SCIENTIFIC AMERICAN SUPPLEMENT. No. 1437

Entered at the Post Office of New York, N. Y., as Second Class Matter.

Copyright, 1903, by Munn & Co.

Scientific American, established 1845
Scientific American Supplement, Vol LVI. No 1437.

NEW YORK, JULY 18, 1903.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

HIS HOLINESS POPE LEO XIII.

HIS HOLINESS POPE LEO XIII.*

GIOCCHINO VINCENZO RAFAELLO ALOYS PECCI, who was raised to the pontificate in 1878, under the title of Leo XIII., was born at Carpineto on March 2, 1810. There are several Carpinetos in Italy, but the town where young Pecci was born is near Velletri. It is a picturesque little place, which is rarely visited except by students or artists. The Pecci family comes of a noble Siennese stock, and lived in the Pecci palace adjoining the Cathedral Square of Carpineto. The child who was one day destined to become Leo XIII. was the fourth son of Count Domenico Lodovico Pecci. At the age of eight Giocchino, or Vincenzo as he was usually called, was taken with his brother to Rome, where they were left for some months in the family of their uncle. They were then sent in 1818 to a Jesuit college at Viterbo. The teachers took a great fancy to little "Nino;" he gave early promise of uncommon literary distinction, and his masters at the time bore testimony of the boy's early piety. After a sojourn of three years at Viterbo he went to the Collegio Romano at Rome; a few months later his mother died. Her chief joy had been the sight of little Vincenzo with the three-cornered cap of the novitiate crowning his placid countenance. So brilliant was his examination, taken at twenty years of age, that a special entry was made in the college record that "He is destined for higher things." During his university studies, young Pecci resided with his uncle Antonio in the Muti Palace.

The uncle seems to have been strongly drawn to Pope Leo XIII. At the Pope's jubilee young Pecci was unanimously selected to head a deputation of students and to present to the Pope a Latin address of thanks. In his twenty-eighth year young Pecci was appointed Referendary to the Court of Segnatura, which indicated that the Sovereign Pontiff and his Councilors had already discovered in the young man administrative talent of a high order.

In the same year he received the holy orders of subdeaconship and deaconship, and on the last day of the year 1837 Cardinal Odescalchi conferred the order of priesthood on Giocchino Pecci, whose life was henceforward devoted to the Holy See.

On his ordination he was appointed Apostolic Protonotary for three provinces. On January 27, 1843, he was ordained Archbishop. He was not assigned to full possession of an ordinary see, but was made titular Bishop of Damietta *in partibus*. He was then sent as an envoy to Brussels, holding this position for three years. In 1846 he was appointed Archbishop of Perugia, continuing in this position for thirty-two years. In December, 1850, he was created Cardinal of the order of priests. In the administration of his province he displayed much ability, put an end to brigandage, and effectually repressed crime.

Cardinal Pecci was subsequently made Chamberlain. On the death of Pius IX., he organized the conclave of Cardinals, which, after a sitting of thirty-six hours' duration, elected him Pope on the third ballot. This was on February 20, 1878. He took the name of Leo, and was the thirteenth Pope to assume it.

He entered upon his pontificate at a most difficult time. Deprived of temporal power, he was little better than a prisoner at Rome, for, like his predecessor, he found himself unable to accept the conditions of settlement offered by the Italian government. He was a man of large mind, however, and took full cognizance of the tendencies of modern politics and society. The Nihilists and Socialists of Russia and Germany received his early attention, and Prussia was at this time in a state of religious ferment. Finally the difficult task of reconciliation with Germany was accomplished. He did all in his power to encourage the study of the philosophy of St. Thomas Aquinas in the schools, as he was very much of a believer in the writings and teachings of the "Angelic Doctor." In 1882 he issued an encyclical calling upon the Catholics throughout the world to form religious societies and to devote themselves to the re-establishment of the papal liberty of person.

The year 1883 was signalized by the seizure by the Italian government of the property of the Congregation de Propaganda Fide. This placed a still greater barrier between the Quirinal and the Vatican, but at the same time matters improved very much in Germany and in other parts of the world. A further confiscation in 1884 by the Italian government of property belonging to the Propaganda caused the Pope to establish stations in other countries, where the offerings of the Catholics throughout the world might be safely stored and invested. In 1885 the Pope acted as arbiter in the dispute between Spain and Germany as to their rights in the Caroline Islands.

A man of mildness, but of great executive power, Pope Leo XIII. will ever be known as "Leo the Pacific." With his delicate bodily organization it would seem that little could be expected of him, but by a rare combination of firmness and tact he won for himself a title to lasting renown.

We will now describe the environment of the Holy Father.

The Church of Rome is to-day the most remarkable corporation in the world, and it presents points of interest even to those who do not hold its tenets. Modern Popes are self-confined prisoners in the Vatican, are the most picturesque figures in the world of to-day; and it will perhaps be interesting to gain some idea of the palace where these regal religious recluses live. Owing to the differences with the Italian government relative to the temporal authority, the Pope chose, like his predecessor, to remain a prisoner in the vast Palace of the Vatican, which adjoins the great Basilica of St. Peter's on the right bank of the Tiber at Rome, though until the unification of Italy he dwelt in other palaces or his beautiful villa at Castel Gandolfo on the bank of the Alban Lake, a few miles from Rome.

The Vatican is the largest palace in the world, and was originally a dwelling-house of the Popes. It was begun by Symmachus (496-514) and it was enlarged by subsequent Popes, but their usual residence was the Palace of the Lateran. When the Pope returned from Avignon after the Great Schism, the Lateran was deserted. In 1410 John XXIII. constructed the covered passage connecting with the Castle of St. Angelo. In 1450 Pope Nicholas V. set about making it the most imposing palace in the world. In 1473 the Sistine Chapel was erected by Sixtus IV., the Belvedere was built by Bramante in 1490, and the Loggia was also built by him. In 1534 Paul III. founded the Pauline Chapel and Sixtus V. the Library and the present living apartments of the Popes. The Palace possesses twenty courts and eleven thousand halls, chapels, salons and private apartments. By far the greater number of these are occupied by the vast collections of statuary, paintings, and antiques. The library is also superb and contains priceless manuscripts. To the student of either antique sculpture or modern painting the Vatican is a Mecca. Here is the Sistine Chapel, whose walls were painted by some of the earlier men who made the Renaissance possible—Perugino, Pinturicchio, Botticelli, and Cosimo Rosselli; while the vast ceiling contains the greatest work of Michelangelo's brush, and on the end wall is the "Last Judgment," a great work and a world-famous fresco. Here are also the Stanze—the apartments painted by Raphael and his scholars, including the "School of Athens" and the "Disputà." The Loggie of Raphael contain the frescoes painted under his direction and familiar to all as the most popular Bible-pictures in the world. The Picture Gallery includes Raphael's "Transfiguration" and the "Madonna da Foligno," besides some of the choicest works of the Italian school. These are all readily accessible to the general public under proper regulations; and now even the Borgia apartments, which for centuries were closed even to the art student unless he had introductions in high quarters, are open. Of course only a comparatively small part of the buildings are used for the papal court, and in reality it is a little world of its own, for by a law passed May 13, 1871, the Vatican, Lateran, and the papal villa at Castel Gandolfo secure the privilege of exterritoriality.

We have already in SCIENTIFIC AMERICAN SUPPLEMENT, No. 1217, told how a Pope dies, how his successor is elected, and how he is invested with the insignia of his exalted office.

The Majordomo is the supreme master of the Vatican in all things relating to daily life, selecting his subordinates, and it is to him that application for tickets of admission to ceremonies, etc., is made. The Chamberlain arranges all audiences; other officers of the household of the Pope control various things, as libraries, etc. There are secretaries of all kinds, protonotaries, and a host of other officers, each having an important position to fill and all working in harmony to make the whole machine of the Church run smoothly. There are a host of lay dignitaries, including the Garde Nobile, the officers of the Swiss Guard, etc., and in addition there are the soldiers themselves of the two bodies which form the last remains of the army of the States of the Church. In addition there are of course chairmen to carry the "gestatoire" and the Sedan chair, cooks, valets, etc.

When the order is given to escort the Pope to a ceremony in the Vatican or St. Peter's, 500 armed men form a guard. In the barracks built by the Borgias there are 200 Swiss Guards with their strange parti-colored costumes of black, red, and yellow with steel halberds on their shoulders. They line the interminable corridor which he must traverse to get anywhere even in his own palace. Since the beginning of the

THE POPE'S BEDROOM.

PANORAMIC VIEW OF PART OF THE VATICAN FROM THE DOME OF ST. PETER'S, ROME.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

sixteenth century the Swiss Guards have been chargeo with the care of the Pope at the Vatican. The Catholic Cantons of Switzerland consider that it is a great honor that a guard of the Pope should be taken from men of their nationality. Day and night these faithful men guard all approaches to the Vatican. The Palatine Guards, which are recruited from the city for the ceremonies, are dressed uniformly in blue and they carry guns without cartridges. Their office consists largely in helping to make way for the pontifical cortege. They are really the reserves of the pontifical army. They number 400, and about every three weeks they take turns in mounting guard in the antechambers of the Pope, and these days of duty are considered among their comrades to be a great honor. More military in aspect are the Pontifical Gendarmes. They are 120 in number, and are the pontifical police. The body guard is composed exclusively of the Garde Nobile, and they number 200 in all. They are selected from the gentlemen of the most noble Roman families, and in their splendid uniforms and with clanking swords they make a fine appearance.

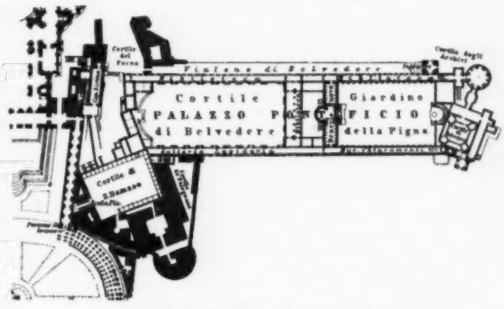
ANTECHAMBER AND PRIVATE CHAPEL OF THE POPE.

The ceremonies in St. Peter's are most impressive, and have to be seen to be appreciated. The vast church itself can accommodate 54,000 persons on occasions. At 10 o'clock in the morning, when the Pope is to officiate he descends to St. Peter's, and for two hours before the procession forms to conduct the Pope from his palace to the great basilica. The Swiss Guards and the Garde Nobile lead the procession, and then come the mace bearers of the Pope. They are dressed in violet. In Rome everything is evolved from something which has gone before, and so they are really the descendants of the ancient lictors who preceded the magistrates of pagan Rome. The lictors, however, carried axes, the symbol of right of life and death which was possessed by the magistrates; while the mace bearers of the Pope carry the keys of St. Peter. The chamberlains follow with the princely assistants, who consist of the descendants of noble Roman families. They are dressed in black and have a short cloak, black gloves, and carry a sword and silver guard. The Sacred College follows, the Cardinals defiling in order. They are dressed in soutanes. Then come the Bussolanti, who carry the great fans of ostrich plumes, and then come the bearers, who carry on their shoulders the Sedia Gestatoria. Slowly the chair advances, the faithful parting on both sides of the procession to allow it to pass. The Pope in full vestments sits upon this movable throne. When Leo XIII. was carried on the Sedia, he used to say that it made him seasick, and the motion of the bearers is certainly very nervous. All eyes are fixed upon the mild old gentleman in his superb robes, his head surmounted by the papal tiara, his hand rising in benediction. The great cathedral, or basilica to speak more properly, is splendidly decked for the occasion, and the music is superb. Twenty-nine tonsured singers form the chorus, and they are dressed in the ecclesiastical costume. They form the papal choir, and sing before the Pope on all great occasions, and they have no organ. They read from bits of music books entirely written by hand. The music is superb, and those who have once listened to it will never forget its solemn and awe-inspiring nature.

The gardens of the Vatican are now the sole territory which His Holiness controls in Rome. They are of considerable extent, and here the Pope drives and rides in a chair carried by bearers. The views in the various paths are delightful, and from them the Pope can see the houses and factories of the new quarter. The gardens of the Vatican properly speaking occupy the space between the wall of Leo IV. and the modern fortified *enciente* of Urban VIII. There are formal gardens, casinos, and long alleys bordered with trees and box hedges. The Casino del Papa was built by Pius IV. from the designs of Pirro Ligorio. It is decorated with paintings by Baroccio, Zucchero, and other painters of the Decadence. This casino is much used by the Pope during the summer. In the upper part of the gardens a portion of the mediæval wall of Leo IV. with two towers is still standing, beyond which Pius IV. and Urban VIII. extended the present bastions. It was from the most western and elevated point of the latter, which enfilade the post-road from Civita Vecchia, that the French army suffered so severe and unexpected a repulse on their first approach to Rome in April, 1849.

The apartments of the Pope are in the great palace and in the casinos. Our engravings show three of the private rooms: the salon of the Garde Nobile, who attend to the small oratory or chapel which opens out from it, of His Holiness; his bed-chamber; and the Throne Room, where Italian Cardinals receive the red cap. The rooms are all imposing, and on the whole are in very good taste. They have been recently photographed by a Florentine firm.

The Pope recently had the Vatican art treasures appraised by professional experts. They valued the picture gallery at $14,000,000, reckoning Raphael's "Transfiguration" at $1,200,000. The Egyptian Museum was valued at $11,000,000, the collection of coins at $4,000,000, the Borgia Museum at $3,000,000, various other collections $8,000,000. The Vatican Library was valued at $40,000,000. Altogether, collections and art treasures were rated at $120,000,000. The furniture in the Vatican was valued at $2,000,000, sacred objects $10,000,000, jewelry and precious stones $14,000. The Basilica of St. Peter has statuary, mosaics, sacred objects, etc., which are worth $20,000,000. These figures are not based on guesswork, but were obtained after a minute and searching examination by experts; therefore the "movables" of church and palace cannot be worth much less than $175,000,000. Certainly no two buildings in the world can approximate these figures,

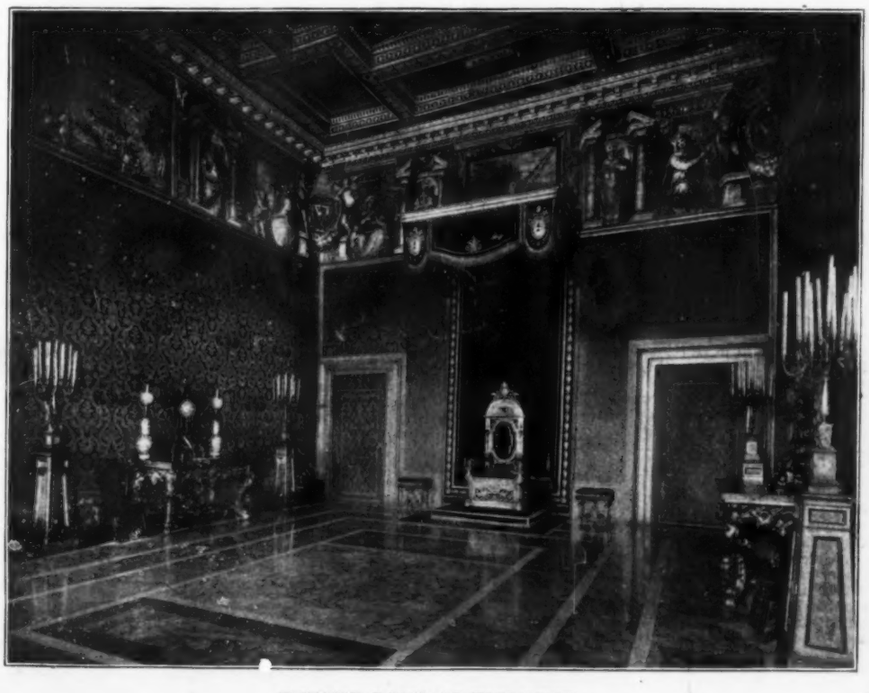


PLAN OF THE VATICAN.

and the Vatican and St. Peter's are probably worth $100,000,000 more.

A NEW ACCUMULATOR.—D. Tommasi has invented a new accumulator, which appears designed for light weight. The plate is made up of a frame of lead containing 81 cases of lead plates. Each case has an area of 15 sq. mm., and contains seven lead plates. In one case the plates are laid horizontally and in the adjacent ones vertically, and so on alternately. The plates are separated by narrow intervals, which are filled with the active matter. Perfect diffusion of the liquid is thus secured, and there are no concentration currents. The author gives some figures concerning the accumulator as actually made: Number of plates 5, being 140 mm. square and 3 mm. thick; total weight, 2 kg.; time of discharge, 5 hours; E. M. F., 1.9 volts; current, 6 amperes; capacity, 2.8 ampere-hours; power, 11.4 watts; energy, 54.15 watt-hours, or 33.7 per kilogramme of plates. For a yield of 1 ampere per kilogramme of plates we, therefore, have a capacity of 34 to 38 ampere-hours, or a useful capacity of 22 to 24 ampere-hours per kilogramme of plates.—D. Tommasi, Comptes Rendus, December 29, 1902.

"Butter Help."—"Butter Help," according to Secretary J. N. Hurty of the Indiana Board of Health, "is made by mixing water with neutral fat by means of a mucilage made of Irish moss. The 'help' comes in barrels from Chicago and looks and smells like butter. It contains from thirty-five to forty per cent water. It is used by mixing the butter in any quantity desired." The mucilage from Irish moss makes it possible for water and fat to coalesce and form a solid. The mixture is of the order of the "butter expander" fakes which received the attention of the United States Agricultural Department at Washington some years ago.

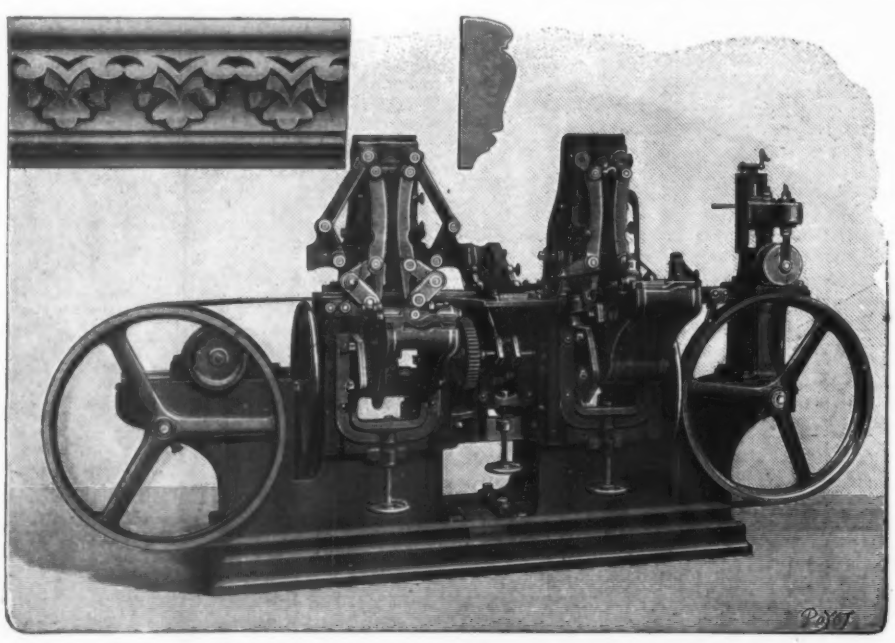


THRONE ROOM OF THE POPE.

MACHINE FOR CARVING WOOD MOLDINGS.

THE process usually employed for the manufacture of plain wood moldings is quite simple, because the latter possess a continuous and uniform profile, which is obtained by means of a molding-plane, the depressions and reliefs of the blade of which correspond to those of the profile that it is desired to produce. But, up to the present, in order to manufacture complicated moldings of a non-continuous profile, it has been necessary to secure to a backing of wood various ornaments molded in a plastic material, and which have an unfortunate tendency to become detached from their support. This process has the disadvantage of being slow, tedious and expensive.

In order to obviate such inconveniences, M. Marbut, a French inventor, has devised a machine by means of which moldings of a multitude of patterns of the most complex character may be turned out at the rate of 16 running feet per minute, in the case of wide ones, or of 40 in that of narrow ones. The invention is based essentially upon the fact that it is possible to carve reliefs with surfaces that are curved or are oblique or perpendicular with respect to each other, by the meeting of planes produced by the action of chisels or gouges of proper form and having variable inclinations. If we consider as the raw material of the molding a strip of wood or a molding presenting an ordinary profile, it will suffice to distribute the attacks of the chisels or gouges in two series—those perpendicular to the strip of wood and those parallel with it and entering it edgewise. The meeting of the sections thus made in the wood will cause the detachment therefrom of small pieces in the form of parallelopipedons, which will leave the desired reliefs upon the strip. Let us note that the result is facilitated by the fact that it is possible to work upon a strip of wood that has already been molded longitudinally. In order that this explanation may be understood it will be well for the reader to glance at the type of molding figured in the cartouche accompanying the engraving that illustrates this article and in which will be seen also the general and longitudinal profile of the molding that is afterward carved by the Marbut machine.



MACHINE FOR CARVING WOOD MOLDINGS.

A close examination of this figure will permit it to be understood that the forming of the inverted circumflex accent, so to speak, that decorates the top of the molding may be effected by the meeting of the sections made by an angle gouge working vertically and two gouges entering the wood obliquely. The part immediately beneath is carved by an angle gouge entering the wood vertically, and then by another and slightly analogous one working parallel with the surface of the strip of wood. These actions of the chisels take place of course in several successive operations; and, moreover, it is necessary that the form and depth of entrance of the various tools shall be minutely studied in order to have them produce the desired chiseled *motif*. It requires quite a large number of tools to obtain the desired relief, but the latter is given with great precision by the automatic machine in which they are used after it has once been regulated.

Without entering into minute details, we shall have a few words to say as to the operation of the apparatus, a photograph of which is reproduced in the accompanying engraving. The two large wheels seen to the right and left serve to carry along the strip of wood, which rests upon an endless steel belt actuated by the wheels. Owing to a control by worm gearing, of which the thread is now and then horizontal, the motion is intermittent, and the stoppages permit the wood to undergo the successive actions of chisels and gouges mounted upon the vertical or horizontal tool-carriers seen in the engraving. In reality, it is possible to cause five groups of chisels or gouges to act upon the strip of wood and to make them enter the latter obliquely in order to obtain the most varied combinations of several intersecting planes. It is possible for certain of the tools, moreover, to carve the wood from beneath. Finally, let us add that there are two tool-carriers arranged for giving a rotary motion to the tools, so as still further to increase the number of ornamentations that the machine is capable of producing. We shall not dwell upon the mechanical control of the motions, which is effected through the intermedium of cranks actuated by a longitudinal shaft with the interposition of telescopic arrangements which facilitate the putting in place and regulating of the cutting tools, and, at the same time, render it possible to work strips of wood of variable thickness.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

MARINE ENGINES.

KEROSENE VS. GASOLINE.

By A. E. POTTER.

THERE is no denying the fact that, unless thorough precautions are taken, there is a considerable element of risk attending the use of gasoline, especially when employed for marine propulsion; that the risk is by no means imaginary is proved by the fatal accidents that too frequently occur. The risks, to be sure, may be almost entirely removed, provided the installation is intelligently and properly made, no leaks are permitted, and a careful, competent person is in charge. Still the danger is recognized, and vast amounts of money have been expended in trying to overcome the natural objection to its use. In engines using gasoline vapor under pressure generated with heat, obviously the danger is decidedly greater than in engines of the explosive type. In the alco-vapor and similar engines, not using gasoline at all, these objections have been, of course, practically removed.

In explosive engines there are fundamental principles involved, which either are not fully understood by designers and constructors, or which they have been unable to master, in this type of engine, especially if designed for the use of kerosene.

The kerosene engine of to-day is an evolution from the ordinary explosive gas or gasoline engine. The wide range of the explosive proportions of air and gasoline vapor is in a measure responsible for the fact that many poorly-designed and more poorly-constructed engines are able to run at all. With kerosene, the proportions of the mixture must of necessity be very much more exact.

The ignition is a simple matter in gasoline as compared to kerosene engines. The electric spark, as used in the former type, furnishes the ideal ignition, as by its means one can time the explosions perfectly, something that is not possible with the hot tube or hot ball ignition, such as is usually employed for kerosene engine ignition.

All kerosene engines that I have yet examined have serious defects, some of which could be remedied provided the designers had the courage to leave well beaten paths and make investigations along original lines. Very few makers can tell you to-day what primary compression, generally termed crank-case compression, gives best results; whether three or four pounds, which appears to be the limit, is too little; and whether or not an increase to seven or eight or even fifteen pounds would not give much better results, by allowing a later exhaust, with a correspondingly higher mean effective pressure and a more even quality of mixture. Moreover, mechanical means could be used to assist in vaporizing, thereby giving the finely divided kerosene a better admixture with the air. Again, it is difficult to time the explosions in kerosene engines. They are liable to occur too early, stopping the engine, and frequently breaking the connecting rod or crankshaft. More often they occur too late, especially in high-speed engines, and involve a decided loss in power.

The fuel supply may be used to regulate speed; but if this is done, the explosions will be weak, with resultant smoke and products of imperfect combustion. If the supply of air is throttled, the result will be the same; except that in the one case the charge will be too poor, and in the other, too rich, while in both there will be poor combustion, smoke, and deposit of soot on the walls of the cylinder, in the ports, and in the exhaust. I know of no kerosene engine on the market that is so governed that the same relative proportion of air and kerosene oil vapor is always maintained. In this respect the manufacturer of two-cycle gasoline engines is more fortunate, for he can draw an explosive charge into the crank-case, compress it there, and force it into the explosion chamber. This gives him a better mixture than the kerosene engine manufacturer can get, as kerosene used in this way would not be held suspended by the air in sufficient quantities to become explosive, and it would accumulate in the crank-case.

There is a method, however, by which it is possible to get a perfect mixture of kerosene vapor and air in proper proportions, vary it at will, handle it, throttle it, and explode it just as one would a gasoline mixture. It does not involve much complication or greatly increased cost. In, for instance, a 6-inch by 6-inch single-cylinder two-cycle engine, with exhaust port opening at 75 per cent of the stroke and inlet port opening at say 85 per cent, it is rarely possible, with no leaks, to get a compression of more than four pounds to the square inch. This would prove that the clearance must be 3 2-3 times 85 per cent of the piston displacement (144 cubic inches), which would be 529 cubic inches.

Inversely, given a clearance of 529 cubic inches and a displacement of 144 cubic inches, with inlet valve closed, there would be a vacuum equal to 8 inches of mercury. Allowing for loss by wire-drawing, or friction of incoming air, in operation this vacuum will frequently exceed a maximum of 4 inches of mercury at the expense of the volume of the charge of gas drawn into the crank-case, as noticed when the vacuum gage has been connected to the crank-case with suitable swing check valve.

Supposing the clearance were to be equal to the displacement of the piston, 144 cubic inches, the compression would equal 14.7 pounds, while the vacuum would be something like 15 inches of mercury, sufficient to thoroughly vaporize the kerosene. If this primary compression chamber is higher than the vaporizing device, and all surplus kerosene can drain back to the vaporizer, instead of collecting in some low place, the finely-divided or vaporized kerosene will pass from the compressing chamber into the firing chamber, where it can be exploded by means of an electric spark, as the mixture would be uniform. Heated air would also tend to assist proper vaporization, and as there is always a surplus of heat in the exhaust, hot air is always available.

SELF-IGNITING DEVICES FOR COAL-GAS.

M. A. LECOMTE recently read a paper before the French Société Technique du Gaz, upon Canioni's self-igniting arrangements for coal-gas. Canioni still employs platinum as the active metal, for although several other metals are available for the same purpose they all have defects of their own. Palladium is the most active of the metals capable of rising to a high temperature when exposed to a stream of raw gas and air, but it volatilizes at 1,500 degs. C. Iridium is more refractory than platinum, but it is also less efficient; and in time it volatilizes from the hottest part of a non-luminous gas flame. Platinum is therefore still the best substance to use, provided a sufficient quantity is taken, and distributed on a properly porous support. Canioni prepares his active pills by precipitating a solution of an aluminium salt so that the aluminium hydroxide (hydrated alumina) falls in a gelatinous condition; he then pours off the liquid, dries the residue, and forms it into the desired cylindrical shape in agate molds. The pills are next heated in a powerful furnace till all the water is driven off, and before they have had an opportunity of becoming damp they are put into a 10 per cent solution of platinum chloride in alcohol, remaining there for about a fortnight till they have absorbed the predetermined quantity of metal. Finally, they are ignited in a gas flame. Such igniters retain their activity even after exposure in a gas flame, day and night, for ten months; and even if kept for three hours in air artificially saturated with moisture, only become less rapid in firing a current of gas. If they are constantly exposed to a leak of gas their pores may become choked, but they are rendered active again by blowing upon them. After a twenty-three hours' rest these igniters fire coal gas in from four to fifteen seconds' time. In Canioni's lighter for incandescent burners the apparatus is carried on an elbow from the base of the burner proper, and comprises three upright extensions, bearing the pill, the jet of a pilot-flame, and an iron-jacketed tube containing mercury respectively. The orifice leading to the main burner is normally closed by a weighted valve operated by a lever lying in the elbow. When the gas is turned on it cannot pass to the burner proper, and is therefore diverted to the jet below the igniter and to the pilot flame. The igniter then glows and fires the pilot; the heat from the latter expands the mercury in the glass tube (which is closed at the top), forces the liquid downward, and causes a small india rubber bag to be distended. The expansion of this bag depresses the lever aforesaid, opening the gasway to the large burner, and simultaneously cutting off the supply to the igniter and the pilot. When the burner is put out the mercury contracts again, the rubber bag shrinks, and leaves the whole arrangement as it was at first.

AMERICAN RAILWAY EQUIPMENT.

ON June 30, 1902, there were 41,228 locomotives in the service of the railways, which was 1,644 more than were in use in 1901. Of the total number of locomotives, 10,318 are classed as passenger locomotives, 23,594 as freight locomotives, 6,683 as switching locomotives, the remainder, 633, not being classified.

The total number of cars of all classes in the service of the railways on the same date was 1,640,220, there having been an increase of 89,387 in rolling stock of this class. Of the total number of cars, 36,991 are assigned to the passenger service, 1,546,132 to the freight service, 57,097 to the direct service of the railways. The foregoing figures do not include cars owned by private companies and firms that are used by railways, as no returns for them are made to the Interstate Commission.

The report of the Commission contains the usual summaries to indicate the density of equipment and the extent of its use. They show that the railways

of the United States used on an average 206 locomotives and 8,195 cars per 1,000 miles of line, that 62,985 passengers were carried, and 1,908,310 passenger miles accomplished per passenger locomotive, and that 50,874 tons of freight were carried, and 6,666,499 ton miles accomplished per freight locomotive. Embracing in the term "equipment" both locomotives and cars, it is noted that the total equipment of railways at the end of the year was 1,681,448. Of this number, 1,306,849 were fitted with train brakes, the increase in this item being 142,801, and 1,648,535 were fitted with automatic couplers, the increase being 98,695. Nearly all locomotives and cars in the passenger service were fitted with train brakes, and of 10,318 locomotives assigned to that service 9,462 were fitted with automatic couplers. Practically all passenger cars were fitted with automatic couplers. Regarding freight equipment, it is observed that nearly all freight locomotives were equipped with train brakes and 94 per cent of them with automatic couplers. Of 1,546,132 cars in the freight service, 1,204,929 were fitted with train brakes and 1,520,997 with automatic couplers.

THE WORLD'S COAL PRODUCTION.

THE rapidity with which the production of coal has increased may be appreciated when the present volume of that production is considered, in conjunction with the phenomenal increase in output within recent years. In 1864 the world's produce of coal was 171,000,000 tons; in 1883 it was 444,000,000, and in 1901, 773,000,000 tons, according to the Bureau of Statistics at Washington. The statistics of production for earlier periods cannot be determined with any degree of precision, but on the basis of the British statistics subsequent to 1854, and of estimates for earlier periods, and from such statistics as are obtainable from France, Germany, Belgium and Austria-Hungary, an approximation may be made of the actual production. In 1860 the world's production of coal was about 141,000,000 tons, or less than one-fifth of the production of 1901, and considerably less than the output of the United Kingdom or the United States at present. Ten years earlier the world's production amounted to only about 83,000,000 tons, about one-tenth of the present production. In 1840 the production was much smaller still, amounting to little over 40,000,000, while during the three-quarters of a century, since 1820, when the output was about 17,000,000 tons, the production has increased in enormous proportions. While the figures of the world's production prior to 1864 are necessarily defective, owing to the absence of accurate statistics, they indicate sufficiently the immense development of the industry during the last century. The production of coal is chiefly in the hands of three nations—the British, American, and German. During the last thirty years, and even before, the combined coal output of the United States, the United Kingdom, and Germany has averaged year for year, about five-sixths of the coal output of the world. Possessing only a tenth of the world's population, they have produced about 83 per cent of the mineral fuel, while the remaining 90 per cent of the world's inhabitants have produced only about 17 per cent of the coal, and even if the savage and semi-barbarous nations be disregarded, the immense preponderance of coal production in these countries must be conceded. To this group might be added Belgium, which produces and consumes more coal per capita than any other European country, except the United Kingdom, but the fact of its small population places it in the second rank of coal-producing countries. While the continued output of these three countries has kept pace with the production of the rest of the world, their relative position has been materially altered. In 1868 the United Kingdom produced over three times as much as either the United States or Germany, the output of these countries being approximately 52, 14.5, and 16.5 per cent of the world's production. In 1870 the proportion was about the same, although the United States had gained upon Germany as a coal producer. By 1875 the output of the United Kingdom was still considerably greater than the combined production of the United States and Germany, the output of these three countries being 45, 20 and 18 per cent of the world's production respectively. The next half decennial period witnessed a remarkable increase in the American production and a corresponding relative decrease in that of Great Britain, the proportions of the three countries under consideration being 36, 28 and 17 per cent respectively. This increase was maintained during the latter part of the past century, and in 1896 the output of Great Britain and Ireland was only 34 per cent, that of the United States already 30 per cent, and that of Germany 19.2 per cent. of the coal production of the world. In 1899 for the first time, the coal production of the United States exceeded in quantity that of Great Britain. This superiority was maintained for two successive years. During 1901 the United States production was greater than the amount of coal produced in Great Britain and all her colonies. During that year the shares of the leading coal-producing countries were as follows: United States, 34 per cent; United Kingdom, 28 per cent; and Germany, 19.2 per cent.

VANADIUM STEEL.

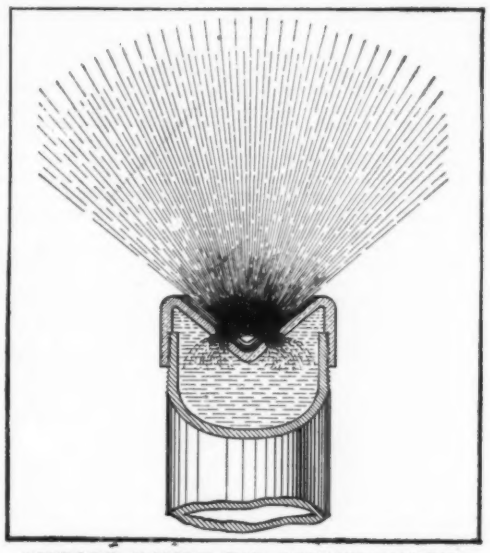
METALLURGIC circles, especially abroad, have been interested recently in the singular properties of vanadium steel.

It appears that when from three to five parts per thousand of this metal, which is as yet very little known, are added to steel, it communicates remarkable properties.

Properly speaking, vanadium does not bestow on iron or steel any new property, but it doubles the coefficients of resistance to fracture under all circumstances (shock, crushing, elongation, etc.), and at the same time imparts such extreme hardness as to render it possible to reduce almost by half the thickness of the armor for vessels.

It is difficult to comprehend that the presence of from one-third to one-half per cent of any element whatever in an iron alloy can have so intense and general an effect, though this effect is perhaps explained by the extreme avidity which under certain circumstances, vanadium has for oxygen. This avidity might account for the fact that the presence of even the slightest quantities of vanadium in a bath of steel in fusion would lead to the immediate and absolute reduction of every trace of iron oxide still existing in the mass; now to these traces of oxide, which are inevitable without vanadium, the rupture of the best prepared steels is attributed. Crystals, even microscopic, of oxides would act like the stroke of a diamond on thickest glass.

A peculiar property of vanadium steels is that they acquire their maximum of hardness, not by tempering



SIMPLEX NOZZLE FOR COOLING WATER.

but by annealing at from 700 deg. to 800 deg. C. This has various consequences; for instance, a planing machine whose implement is of vanadium steel is set at work with the greatest velocity and power. Soon the implement becomes heated, and even when it attains red heat, it still continues to take off shavings of iron or castings without exhibiting any exhaustion. It is almost unnecessary to remark that in such a case an implement of ordinary steel would become completely softened and lose its cutting power.

This property is of particular importance for projectiles. It is known that the shock which they experience in reaching their mark, raises them to an elevated temperature. If, by means of vanadium, this temperature does not diminish the hardness of their points, and consequently all their sharpness is preserved, the penetrating force will remain intact.

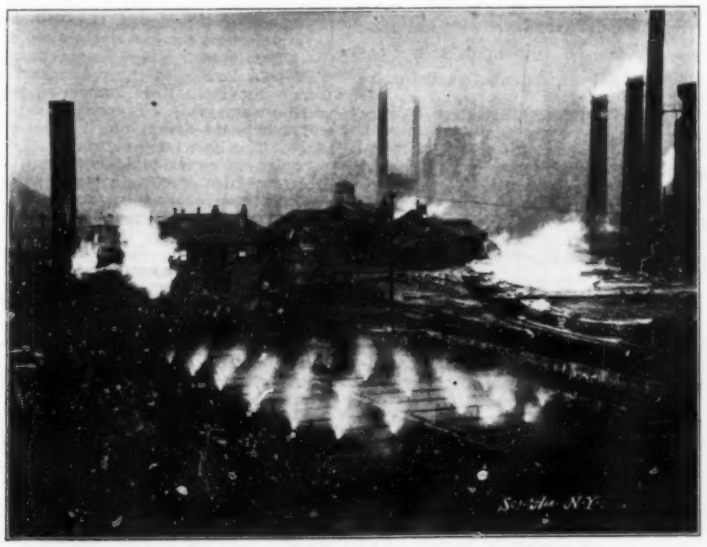
The applications of vanadium may be numerous. It is said that they may cause a revolution in armaments. Incidentally, they would allow the construction of helmets and breast-plates, light and efficacious.

Vanadium has been held as high as 130,000 francs per kilogramme. It is now, we think, worth about 150 francs.—Translated from L'Echo des Mines et de la Metallurgie.

THE SIMPLEX SPRAYING NOZZLE AND WATER COOLING SYSTEM.

THE cost of water is a factor by no means negligible in manufacturing enterprises. When water must be bought, which is invariably the case in large cities and manufacturing towns, it becomes necessary to economize in its use as much as possible. Indeed, it is even found necessary to use it over and over again. In all cases where water is used for dissipating heat, as in power plants, refrigerating plants, breweries and the like, it is almost indispensable to have a cheap and effective device for cooling back the water, so that it can be used over again with minimum loss. Such a device is that which we illustrate, introduced into this country by Edward A. Uehling, of 135 Broadway, New York city.

The device in question is a nozzle, the novel feature of which consists in the manner in which the spray is produced. The advantages are that the water is uniformly spread in a perfect spray, the fineness of which depends on the pressure. Given a head of 10 to 12 feet, each nozzle will spray 1,000 gallons of water per hour evenly over a circular area 10 to 16 feet in diameter. With a head of 35 to 40 feet, about double the quantity of water will be thrown in a fine mist. The nozzle is distinguished by the fact that it will not clog or foul. Anything contained in the water not held by a strainer of ¼ mesh will pass. When large quantities of water are to be cooled and space is available, the arrangement can be used as illustrated in our second figure, which represents a plant cooling back 50,000 gallons of tuyere water per hour. The device would likewise lend itself well to aerial oxidation of chemical solutions; oxygenization of drinking water; distribution of liquids over large filtering areas; cooling pig iron and other materials, and wetting down sand before molding up.



THE SPRAY NOZZLE IN ACTUAL USE.

ABERRATION OF THE SPHERICITY OF THE EYE.

INDEPENDENT of astigmatism, the aberration of sphericity of the eye has been studied but little hitherto. Young barely refers to it in passing, and the only experiments relating to it appear to be those of Volkmann, who made use of an arrangement derived from that of Scheiner, and those of Tscherning, based on the deformation of the images. I will state a fact which seems to me should be referred to the same cause:

If a card is perforated with a pinhole and a look is taken through the hole at a surface uniformly well lighted (the sky is the best in this respect) a luminous portion is seen on the edges, presenting within it a light circular shadow uniform in intensity and limited abruptly by the lighter circular zone surrounding it.

On modifying the size of the hole, it is easy to see that the zone of shadow is the greater as the hole is smaller. Besides, on placing at a certain distance from the hole a translucent paper, or, better, a simple pane of glass, the apparent size of the shadow can be measured with compasses on the glass. Keeping it always at the same distance, the sizes of shadow under different circumstances can be compared.

Thus, on placing the translucent screen at 0.20 millimeter from my eye, I made measurements for holes varying from 2 millimeters to ¼ millimeter.

In the first case the shadow was about .02 meter in diameter and increased gradually to .05 meter in diameter. These figures are approximate, for, in the first place, the measurements are quite difficult, and, in the second place, the phenomenon varies with other conditions than the size of the hole.

If, instead of looking through a single hole, two or three holes are made by the side of each other, they appear as one hole, the different shadows being simply superposed.

On seeking for the cause of this phenomenon, the aberration of the sphericity of the eye alone occurs. For this it is sufficient to remember that the eye is subject to the same aberrations as the lenses commonly employed. M. Tscherning has shown that this is true in most cases.

Let us take a luminous point placed before the eye, and to be specific, suppose that it is farther removed from the eye than the anterior focus. The rays emanating from this point and near the axis will have their focus at a point quite distant, behind the retina. In proportion as we consider the rays farther and farther removed from the axis, we will have foci nearer and nearer to the eye. A caustic curve will result, which will produce on the retina a circle lighted uniformly and surrounded with a zone more luminous.

Replace the luminous point with a lighted hole; each point of this hole will give place on the retina to a spot similar to that described, and from the superposition of these spots will result a central shadow surrounded with a luminous zone. It is easy to see that this central shadow will be the more reduced as the hole is larger, for the different images are then separated the more from each other, and the shadows will have a smaller common surface.

I have sought to submit this theory to experimental verification.

If we limit the luminous pencil entering the eye, either by contraction of the pupil or by placing very

near the cornea a small circular diaphragm, we will eliminate the marginal rays and prevent the phenomenon. A small diaphragm, having at most 2 millimeters of diameter, thus placed, causes the central shadow, which was of great distinctness, to disappear.

It is difficult to say what will pass when the pupil is dilated. For this it would be needful to be better informed on the aberration of sphericity of the eye. Experience shows that the diameter of the shadow increases a good deal, but it declines in intensity. Thus, a hole which gave only a small central shadow in my normal right eye, gave a shadow three-fourths in diameter of the luminous spot in my left eye, when it was dilated by cocaine.

If the power of the eye is increased, the dark spot will diminish in size. Accommodation is not sufficient for this, but by placing near my eye a convergent lens of 30 dioptrics, this effect was quickly produced.

Finally, on keeping this lens of 30 dioptrics near my eye and removing the hole farther off, I saw, when it passed beyond a conjugate focus of the retina, a spot with a maximum of light in the center, which might be anticipated by attributing the effect that I have described in the first place to the form of the caustic.

The central shadow will not appear in all eyes. According to M. Tscherning there are aplanatic eyes and even over-corrected eyes. In these cases, rare, it is true, the phenomenon will not be produced.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT, from the French of M. Georges Weiss. Communication presented to the Académie des Sciences.

INDUSTRIAL APPLICATION OF THE DIASTASES: THE MOST RECENT DISCOVERIES.*

BIOLOGICAL chemistry has made great advance since it was ascertained that biological actions in general (animal and vegetable) are only diastasic phenomena; numerous are now the proofs which confirm this hypothesis.

This question, of very great interest for biological science, is of capital importance for various industries—tanning, brewing, dairy, and natural coloring matters.

A diastase is a product elaborated by a living cell. It is by the aid of the diastases, which it produces, that a cell effects the various chemical operations necessary for its maintenance.

Diastases may be diffused outside of the cell which gave them birth; or, on the contrary, may remain confined in it. If by any means a diastase is extracted, separated from the cell where it was formed, all the phenomena may be reproduced which it occasioned in the organism from which it was extracted.

The diastases are all soluble in water; alcohol reprecipitates them from their aqueous solution. A small quantity of a diastase is capable of converting a considerable quantity of the body on which it acts. The diastase is not destroyed by the action.

For each diastase there is a corresponding temperature, called the best, in which it acts with maximum speed. In general, the diastases do not act at a temperature lower than 0 deg. C.; and a temperature varying according to the diastase, but always less than 100 deg., is sufficient to cause them to lose forever all their properties.†

It is generally admitted that they are albuminoid compounds. The first soluble ferment was discovered by Payen and Persoz and named diastase.‡ It is the soluble ferment of malt or germinated barley and it is now called amylase.§ Amylase converts starch into maltose by simple hydration:

$$\underset{\text{starch}}{2\,(C_6H_{10}O_5)\,n} + nH_2O = \underset{\text{maltose}\,\|}{nC_{12}H_{22}O_{11}}$$

This discovery did not become fruitful until within the last few years.

DIFFERENT CLASSES OF DIASTASES.

The diastases may be classed according to their mode of action: (1) Hydrating and dehydrating diastases; (2) diastases of decomposition and synthesis; (3) oxidizing and reducing diastases.

I. HYDRATING AND DEHYDRATING DIASTASES.

This series of diastases acts on the most varied compounds.

Cytase is found in certain plants in a state of germination. It has been isolated by ordinary means and its solution has been found to have the power of rendering cellulose soluble. The micro-organisms nourished by cellulose all secrete a cytase.

Pectase, comparatively well known, causes the juice of certain fruits to pass to a state of jelly having a cellulosic structure. This is therefore a dehydrating diastase, acting on a kind of soluble hydrated cellulose (pectine), rendering it insoluble.

The migration of starch in growing plants is accomplished by means of two diastases; one renders the starch soluble (hydrating it). The other recovers the soluble starch and renders it insoluble. The concurrence of these two diastases is necessary for the migration of the amylaceous matter of the periphery of the grain to the gemmule, which utilizes it.

Amylase.—The diastase of Payen and Persoz has been separated by M. Duclaux into two diastases, the one, amylase properly so-called, rendering the starch soluble; the other, dextrinase, converting the soluble starch into maltose. Dextrinase acts in a medium slightly acid: it resists at 80 deg., while amylase is destroyed at that temperature. The best temperature for the mixture of the two diastases is 60 deg. to 65 deg.

Maltase.—Maltose is itself separated by a special ferment, maltase, into two molecules of glucose.

$$\underset{\text{maltose}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{glucose}}{2C_6H_{12}O_6}$$

Maltose acts the best at 40 deg. in liquor neutral or slightly acid. It presents the curious phenomenon of being reversible. When glucose and maltose have reached a certain ratio, the phenomenon stops. If maltose and pure glucose are brought into presence, maltose is formed, and the phenomenon stops again at the same proportions of maltose and glucose.

Sucrase or *Invertine* divides saccharose into glucose and levulose in acid solution. The best temperature is 52 deg. The sucrase does not hydrolize the maltose, and inversely.

To this same class of diastases belong the hydrolyzing diastases of the glucosides. These being extremely numerous, their diastases are also found in great number. The diastases of the glucosides may be elaborated by the plant which produces the glucosides. In this case, on the simple digestion of the plant in water, putting the diastase in solution and allowing it to exercise its properties, the glucoside is divided into glucose and an active principle* by micro-organisms (mold in general) nourished by the sugared matter set at liberty during the decomposition of the glucoside.

Emulsin.—Amygdalin, the active principle of bitter almonds, is decomposed by a diastase called emulsin, which is found in bitter almonds, sweet almonds, the leaves of the cherry laurel, and the secretion of the *Aspergillus niger*, etc.

$$\underset{\text{amygdalin}}{C_{20}H_{27}AzO_{11}} + 2H_2O = \underset{\text{glucose}}{2C_6H_{12}O_6} + \underset{\substack{\text{benzoic}\\\text{aldehyde}}}{C_7H_6O} + \underset{\substack{\text{cyanhydric}\\\text{acid}}}{CAzH}$$

Emulsin is capable of hydrolyzing a certain number of glucosides, of which the following are the best known: Salicin, extracted from the bark of the willow, with the addition of water, forms glucose and saligenin (salicylic alcohol); helicin, extracted from the meadow-queen, with the addition of water forms glucose and salicylic aldehyde; arbutin, extracted from the bear's grape, with the addition of water forms glucose and hydroquinone; populin, extracted from the bark of the poplar, with the addition of water forms glucose, benzoic acid, and saligenin. This is the first case of a diastase capable of separating quite varied bodies. Emulsin is even capable of separating chlorated and bromated glucosides from salicin, the division being always made at the same spot to yield chlorated or bromated saligenin.

Myrosin is also a diastase capable of exerting its action on a great number of compounds. It is found in the seed of the black mustard associated with sinigrin. The digestion in water occasions the separation of the sinigrin. Sinalbin, the glucoside of white mustard, is also separated by myrosin.

Lipase.—With lipase we enter on a new group of hydrolyzing bodies. They are the ethers of glycerine, and particularly the fats; lipase saponifies the fats. It is one of the constituent diastases of the pancreatic fluid. It acts in alkaline solution (blood), the best temperature being 60 deg. The formation of soap (the soda salt of the fatty acid) causes the emulsion of the fats not yet saponified and facilitates their absorption by the intestinal walls.

Lipase possesses the curious property of maltase; it is capable of recombining the glycerine and fatty acid; the quantities of glyceride, acid, and glycerine being the function of the acidity or the alkalinity of the liquor. It is the first instance of a diastase behaving like one of the chemical reagents.

The hydrolyzing diastases of starch compounds are to be considered.

Urease, secreted by a certain number of microbes, acts at about the temperature of 50 deg. in alkaline solution. It causes the conversion of urea into ammonium carbonate. The alkalinity of the liquor increasing in consequence of the formation of the carbonate; the urease, which is very sensitive to all the variations of the medium, soon ceases its action. Urease is produced by all the organisms which degrade nitrogenized matters.

Pepsin, or the gastric juice, exerts its action on albuminoid matters in acid solution (chlorhydric acid). Its maximum of action occurs at about 50 deg. The albuminoid matters are hydrated and converted into peptones; the peptones are soluble compounds and have molecules comparatively simple as compared with the albuminoids. There are certain vegetable pepsins.

Trypsin is one of three ferments of the pancreatic juice,† in which it is associated with lipase and invertine (amylase). Trypsin acts in alkaline solution and exerts its action on the albumens and the peptones. The best temperature is 40 deg.

Papine is a vegetable trypsin. It is found in the digestive juice of certain insectivorous plants and the gummy latex of certain trees. The albuminoid matters of the organism must proceed from the condensation of the peptones. There exists, therefore, an inverse diastase of pepsin. There are diastases which are in some cases simple coagulating diastases, and in others dehydrating diastases.

Rennet is met with in the stomachs of all mammifers during the period of lactation and is usually taken from the calf. When rennet is added to milk the casein of the milk is coagulated and becomes an insoluble clot, serving for the manufacture of cheese. The best temperature is 40 deg. in neutral medium.

Plasmase.—The phenomenon of the coagulation of the blood is quite involved. Plasmase is a diastase, secreted normally by the white globules, and does not circulate in the blood after their death (extravasation of the blood rapidly causes their death). The plasmase, set at liberty, coagulates the fibrin, which is free in the blood, or else separates an albuminoid (fibrinogen) into fibrin, which is coagulated, and globulin, which remains in solution. The diastases which are called coagulating (pectates, rennets, plasmase, or fibrin ferment) are considerably accelerated in action by the presence of lime salts. Certain investigators have even undertaken experiments to show that the absence of lime prevents coagulation.

II. DIASTASES OF DECOMPOSITION AND RECOMPOSITION.

The discovery of zymase by Büchner is one of the most important scientific achievements of late years. Previously, alcohol was believed to be elaborated directly from yeast. Büchner, in breaking up the cells in yeast and macerating them in water, and filtering the liquid in order to get rid of all living organisms, obtained a liquor capable of separating a solution of glucose into alcohol and carbonic acid. This diastase had not been previously discovered because the envelope of the cells of the yeast did not allow its extravasation; the laceration of the cells was necessary. This discovery has substituted the theory of diastasic action for that of vital action.

Zymotic action is a general action; many living cells possess the property of elaborating, like the cells of yeast, a zymase, separating the sugar into carbonic acid and alcohol.

We now know that the principal phenomenon of combustion in our organism takes place in the muscles. This phenomenon is, it seems, a zymotic phenomenon; the muscular cells separate the sugar brought to them by the blood into alcohol and carbonic acid; the alcohol undergoes the action of an oxidizing diastase and finally is eliminated in the state of carbonic acid and water. Thus diabetic sugar is due only to a failure of the production of zymase by the muscular cells; the sugar is not separated. Zymase acts in a neutral or slightly alkaline medium.

The lactic fermentation,

$$\underset{\text{glucose}}{C_6H_{12}O_6} = \underset{\text{lactic acid}}{2C_3H_6O_3}$$

is evidently produced by the action of a decomposing diastase. An exceedingly slight weight of microbe converts substantially the whole of the glucose into lactic acid (95 per cent), but the cells of the lactic microbe (bacillus acidi lactici) are so small that they have not yet been broken.

The butyric fermentation must also be attached to this class.

The synthetic diastases, the inverse of the zymases, have not yet been isolated; but there are good reasons for believing that they exist, in consequence of the study of certain fermentations (succinic fermentations).

III. OXIDIZING AND REDUCING DIASTASES.

The oxidizing diastases are true respiratory diastases. They may be compared to the digestive diastases, as pepsin and trypsin. Jaquet was the first to show that the oxygen of the air was fixed by the aid of a diastase on the liquids of the organism, but he did not isolate the diastase of the organs on which he experimented.

Laccase was the first oxydase isolated. It is found in the latex of the lac tree (*Rhus succedanea*), associated with gummy matters and a body of phenolic constitution, laccol. The latex, exposed to the moist air, blackens rapidly, absorbing oxygen and yielding the lac.

Bertrand tested the oxidizing power of the isolated laccase. It converts hydroquinone into quinone, pyrogallol into purpurogalline, and from this carbonic acid is disengaged. The benzenic group, so stable ordinarily, is completely oxidized. We have therefore the phenomenon of inorganic respiration.

The oxydases of the laccase class are widely distributed in the vegetable kingdom. We have a very sensitive reagent for detecting them—tincture of guaiacum. This tincture put in presence with an oxydase is immediately blued intensely.

Tyrosinase is an oxidizing diastase, but distinct from laccase. They may be found associated. It acts on pyrosine, oxidizing it and yielding black compounds. Laccase does not act on tyrosine. Associated with tyrosine, it is met with in certain plants; their simultaneous presence is recognized by the rapid blackening of these plants on contact with air—mushrooms, for example.

The white globules of the human blood also produce oxydases. The acetic fermentation must proceed from an oxydase not isolated.

Reducing ferments are yet very little known; among these is *philothion*, isolated from yeast.

PROPERTIES AND MODES OF ACTION OF THE DIASTASES.

The diastases are soluble in water, also in glycerine, which is a convenient means of extraction. The organs, animal or vegetable, are put in digestion in the glycerine by a phenomenon of osmose, the cells exuding the diastase, which enters into solution with the glycerine. The glycerine extracts can be preserved very well.

Alcohol precipitates diastases from their aqueous extract. The precipitate contains matters insoluble in alcohol, dextrin, gums, albuminoids. It seems rather that the diastases are fixed on these precipitated bodies in the manner of colorants on fabrics, and that they are not themselves insoluble in alcohol.

The excitation of any precipitate within a diastasic liquor involves the diastase with the precipitate. Thus pepsin is extracted by precipitating phosphate of lime in the liquors, or even by introducing a solution of collodion (precipitated nitro-cellulose). The redissolution of these precipitates, followed by a new precipitation, yields a more active product; but this operation must not be continued, for two or three precipitations will often lead to almost the total loss of the diastasic power.

It is to be regretted that attempts to isolate a diastase in a state of purity, in order to submit it to strict analysis, have not been successful.

Diastases are preserved much better in the dry state than in solution; thus, certain diastases may be heated above 100 deg. for which a temperature of 70 deg. in solution is fatal. Light exercises a destructive action on diastases. They are all excessively sensitive to oxygen, which rapidly destroys them, especially urea and rennet.

We have seen that certain diastases act in acid solution (pepsin); others in alkaline solution (lipase). A diastase preferring acids will not act, or will act only feebly, in alkaline solution, and inversely. The acidity or alkalinity is always extremely slight. Thus pepsin, which is the diastase supporting acids the best, acts most favorably in chlorhydric solutions of one or two grammes per liter. Amylase is rendered

---

* From the French of Prof. Lucien Dupont, of the School of Industrial Chemical Products, in the Revue de Chimie Industrielle.

† The thermometer referred to is of course the Celsius or centigrade.

‡ Whence the generic name for all this class of bodies.

§ The name diastase is obtained by adding *ase* to the shortened name of the body which it converts.

‖ Maltose is a sugar which divides after hydration into two molecules of glucose.

* This reaction does not occur in the plant, for the glucoside and the diastase are elaborated by distinct cells.

† The separation of three ferments from the pancreas has been effected.

active by .100 gr. of sulphuric acid, while .020 gr. favors it exceptionally. Lipase behaves the best in presence of two gr. per liter; a stronger proportion diminishes its saponifying power.

The salts act in the same way either for promoting or for retarding. Percentages excessively low are sufficient to favor or retard the quickness of the others. Amylase cannot support the lime salts, which are absolutely necessary for pectase and rennet. Antiseptics act like other salts on the diastases. In fine, it may be concluded that all the diastases are very sensitive to the modifications of the medium.

I have said that one of the distinctive characteristics of the diastases is the disproportion between the weights of the materials converted and that of the diastases. Thus, according to Payen and Persoz, their diastase, though quite impure, was capable of liquefying and saccharizing two thousand times its weight of fecula; in taking one thousand times the weight, the saccharification terminated in ten minutes. Petit found a pepsin, which, in presence of four-thousandths of chlorhydric acid, peptonized 19,200 times its weight of fibrin in two hours. If these numbers seem large as applied to the diastases generally that have been isolated, they are surpassed by the toxines.

It has been thought that the diastases fix both water and oxygen on the bodies which they hydrate or oxidize. But this theory is not sustainable for zymase, which is not decomposed and reconstituted. M. Bertram has shown that laccase contains a good deal of manganese, and that the salts of manganese favor laccase exceptionally. The oxydase faculty would therefore be connected with the presence of manganese. I also recall the rôle which certain authors assign to lime in the coagulation of milk, of blood, and other peptic matters.

Another theory has been recently broached, that of vibratory movement. It has been thought that the diastases are endowed with certain molecular movements, and that by transmission of these movements, the phenomena of hydration, of oxidation, and of molecular separation are effected.

M. Bredig in introducing an electric arc under water between two disks of platinum has obtained a colloidal solution of this metal possessing most of the properties of the diastases. Thus, a colloidal solution of platinum of 0.80 gr. per liter is capable of hydrolyzing sugar-cane like a solution of sucrase. The same platinum solution blues guaiacum and oxidizes pyrogallol. It decomposes oxygenated water like the globules of the blood. The addition of alcohol precipitates the platinum; a temperature of 50 deg. suffices to cause it to lose its properties permanently.

A little more should be said of the toxines. The pathogenous microbes act on our organism by the poisons which they secrete. The greatest analogy exists between these microbian poisons and the diastases. Light, heat, and oxygen affect them in the same way. The toxines are oftenest secreted in our organism by parasite microbes, but certain microbes not originating in the animal system are not the less harmful, for they grow in other mediums, such as alimentary preserves, tainted fish, pork products, in which they elaborate the poisons. The ingestion of these matters causes the ingestion of the toxines and gives rise to numerous cases of poisoning. The toxines differ from the diastases in this respect; the latter act on inert matters, starch, sugar albuminoid, etc., while the toxines act on living matter.

We have seen that the diastases are fixed on certain bodies in the fashion of colorants on the fiber. The toxines act in the same way and fix themselves especially on the nervous center. Fatal accidents are therefore due to the disaggregation of a certain number of nervous cells.

By the side of the toxines may be placed the venom of certain animals, as serpents, vipers, scorpions, and bees, and of certain vegetable products, abrin, robin, and ricin, which produce the same effect.

Lysines or *Alexines.*—The white globules play an important part in our organism. When they are in presence of microbes, perhaps toxic, they surround the microbe and destroy it with the aid of special bactericidal secretions and afterward dissolve it with the aid of other diastases. These secretions are commonly known as lysines or alexines. They are never diffused outside of the white globules, while these are living; that is to say, while the blood is in circulation.

The white globules of an animal are not only capable of dissolving microbes, but they fix and dissolve the red globules of the blood of other animals. The serum of the fowl, for example, dissolves the red globules of the blood of a rabbit. They have also the curious property of secreting special diastases, the agglutinines, capable of collecting in a single mass all the scattered microbes in a culture or all the red globules of the same blood. The agglutinines and the lysines are eminently specific diastases; that is to say, each lysine capable of dissolving a given microbe will not dissolve any other, and a given agglutinine will always agglomerate the same kind of microbes. These diastases are even capable in double cultures of destroying or agglutinating a given body and leaving another. Vaccination against a microbe consists in rendering the serum of the animal bactericidal for this microbe, and for this alone. Very often vaccination causes the formation of a specific agglutinine. It is thus that the typhic serum agglutinates the cultures of the trypki bacillus. The antitoxines are soluble compounds resembling the diastases and capable of communicating to the white globules anti-diastasic properties.

RENNET.

Rennet is a diastase deserving special mention. Milk freshly drawn contains*: (1) Mineral salts, of which the principal are the various phosphates of lime; insoluble tricalcic phosphate, which after a time is deposited and forms a deposit at the bottom of the vessel, and mono- and bi-calcic phosphates in solution; these are the phosphates which give to milk its amphoteric reaction; that is to say, which blue red turnsol and redden blue turnsol; (2) lactose or sugar of milk in complete solution; (3) the fatty matter of the milk, cream, which is kept in a stable condition of emulsion by the emulsive power of the sugar; (4) the albuminoid matter of the milk casein. Of fifty grammes of albuminoid matter, which one liter of milk contains, five grammes are in complete solution. These five grammes are called by certain authors the albumen of the serum. The forty-five grammes of the albuminoid matter are in the state of pseudo-solution. These give to the milk its special corneous transparency. They constitute the veritable casein.

These figures may vary according as the milk has been slightly acidified or boiled, in which case the quantity of the albumen of the serum falls to 2 grammes per liter; or, on the contrary, according as the milk is alkalinized, which renders a part of the casein soluble as a pseudo-solution. M. Duclaux thinks that there is but a single albumen in the milk, the casein, of which one part is in the state of solution, and the other in stable emulsion, the ratios of the two quantities being a function of the mineral compounds which modify the solubility of the casein.

Milk, as it is secreted by the mammary glands, is entirely free from microbian germs, but on its passage through the udders of the cow it receives the lactic bacillus, which constantly exists in the inner folds of the udders, fed by the few drops of milk remaining after the milking. This microbe comes into the milk in full vegetation, and it flourishes there, although the milk is not an excellent medium for it. It is rapidly developed and converts a certain quantity of lactose into lactic acid. This acidity soon arrests its activity, but it prevents the development of the microbes oftenest pathogenous, which are nourished by the albuminoid matter and cause a putrid fermentation. These microbes generally reach the milk in the state of spores, and the spores for their fructification require a neutral medium; or better, one slightly alkaline. This commencement of lactic fermentation is therefore favorable, since in allowing the development of an inoffensive microbe, it removes those that are injurious.

Milk is coagulated under the influence of acids, phosphoric acid excepted. The acids coagulate only the casein in suspension. They cause a part of the casein soluble in a neutral medium to pass to the insoluble state.

Heat facilitates coagulation. Thus, 6 grammes per liter of lactic acid are necessary to coagulate milk at the ordinary temperature, and only 2.5 grammes at 100 deg. Normal milk is coagulated alone at 120 deg. The coagulum produced by the acids is much softer and more transparent than that produced by rennet; while this retains all the phosphates of the milk, the other, caused by the acids, retains much less of them. In alimentary value it is therefore much inferior.

It has been long known that the maceration of certain parts of the stomach of young mammifers in lactation has the property of causing the coagulation of milk, which is converted into a white mass, contracting gradually, and in the end taking the form of the vessel containing it, and expelling a clear liquid, the thin milk, which holds in solution all the lactose and the noncoagulable casein. Like the acids, rennet acts only on the casein in suspension. The action of rennet may be exercised on milk absolutely neutral, but we have seen that the milk is rapidly invaded by the lactic fermentation, so that the phenomenon of coagulation by rennet is aided by the presence of lactic acid.

The rennets commonly employed are those proceeding from the calf and the lamb. The calf rennet being preferable for cow's milk, and that of the lamb for the milk of sheep.

A certain number of vegetable juices are also capable of coagulating milk, such as those drawn from the flowers and roots of artichokes and from the seeds of the lupin and the castor-oil plant. Some of these juices are even employed in different countries for coagulating or aiding the coagulation of milk by rennet; but these juices do not always contain rennet; often it is associated with vegetable trypsins.

The microbes nourished by the casein, and living in the milk, also secrete a rennet which may cause the total coagulation of the liquid. The lactic microbe, which is nourished especially by lactose, secretes little or no rennet and contributes to the coagulation only by its acidity.

Preparation.—It is only from the calf, and a very young calf, that the most active rennet is obtained. Care is taken to remove lumps from the portion of the stomach producing rennet, and it is washed thoroughly with water. Afterward it swells and is allowed to dry. The part nearest the pylorus is rejected, and the remainder cut up in small squares of one centimeter, when a complete extraction is desired. These pieces are macerated in ordinary water at 30 deg. or 35 deg., or at lower temperatures in solutions slightly acidified or salted. M. Soxhlet recommends a solution of sea-salt of 3 to 5 per cent. The maceration should continue for five or six days, and water of about ten or twelve times the weight should be employed. Thus a liquid rennet is obtained, not viscous, and capable of coagulating 10,000 times its volume of milk in forty minutes at the temperature of 35 deg. Often, during the preparation, the liquid undergoes a putrid fermentation. This can be best prevented by adding to the macerating liquor a little boracic acid, 4 per cent. This rennet is an excellent commercial product, although it still contains pepsin, from which it cannot be separated except by complicated treatment.

Force of a Rennet.—This term is applied to the number of liters of milk which a liter of rennet can coagulate in forty minutes at 35 deg. (the temperature of the milk on coming from the udder of the cow).

A measured quantity of milk is placed in a flask 2 or 3 cm. in diameter, and a known quantity of rennet added. The volume is quite small, comprised between 1-1.000 and 1-10.000 of the volume of milk. The tube is kept at the temperature of 35 deg., and the time is noted when the flask can be turned without a drop of the liquid escaping.

The mixture can also be placed in flat vessels and the moment of coagulation determined when, by thrusting the point of a knife into the white mass, the lips of the cleft are firm, and the liquid is perfectly transparent. To be exact, the time of coagulation should not be less than 15 minutes, nor more than 90 minutes.

Knowing what has been proved by the experiments of M. Duclaux that the time of coagulation is for the average percentages which I have mentioned inversely proportional to the quantity of active rennet (consequently to its force), we find the force by multiplying the ratio of the volume of the milk to that of the rennet by the inverse ratio of the time of coagulation to the typical time (40 minutes).

For example, if to 50 cubic centimeters of milk we add .05 cubic centimeter of rennet (or .5 c.c. of rennet diluted to one-tenth) and we have found as the time of coagulation 20 minutes, the force of the rennet will be $\frac{50}{0.05} \times \frac{40}{20} = 2{,}000$. This measure is necessarily a little illusory; it is exactly true only for the milk which has served for the measure. We have seen that the acids coagulate milk; in quantity insufficient for coagulation alone, their action is added to that of the rennet, and the time of coagulation is diminished.

Certain salts, particularly the alkaline salts, added to the milk at the same time with the rennet, retard the time of coagulation. One gramme of potassium oxalate per liter allows coagulation only at the end of a period fifty times as long. One gramme of sodium carbonate per liter prevents coagulation altogether.

Other salts, especially those of calcium and barium, on the contrary, diminish the time of coagulation; thus, two grammes of calcium chloride per liter reduce the period to one-fifth the normal time. The same salt in the proportion of 100 grammes per liter causes it to continue four times as long. The antiseptics retard, and here we are not concerned with those introduced into the rennet and designed to prevent its putrefaction; the percentages being quite small, the quantity of these antiseptics is negligible. We refer to those which are added to the milk itself. Sodium fluoride, .5 gramme per liter, yields the coagulum at the end of a period three times as long; 5 grammes per liter prevent it altogether. Sodium bicarbonate acts in the same proportions. Sodium borate, 1 gramme per liter, renders the coagulation four times as slow; in the proportion of 2 grammes per liter, it is sixteen times as slow. Boracic acid, 1.5 grammes per liter, renders it twenty times as slow. Thymol destroys rennet quite rapidly, and formic aldehyde, in the proportion of 1.5 grammes per liter, prevents coagulation. The antiseptics, slightly alkaline, added to the milk for its preservation, retard coagulation, (1) by enfeebling the microbian rennets; (2) by neutralizing the lactic acid secreted by the lactic bacillus—two causes of the spontaneous coagulation of the milk.

The temperature also influences the rapidity of the action. At 15 deg. rennet does not act on milk; at 40 deg. it presents a maximum of action; at 60 deg. there is no further action.

The state of the casein influences also the rapidity of the action. The rennet coagulates only what is in pseudo-solution; thus milk, heated at 60 deg. and cooled, coagulates much less quickly than ordinary milk, and with more reason than boiled milk. We have noticed that rennet is an excessively active diastase; thus, it has been calculated that dry rennet, and naturally quite impure, coagulates 250,000 times its weight of casein, or about 5,000,000 its weight of milk.

The mechanism of the action of coagulation has raised much discussion. According to M. Duclaux (Traité de Microbiologie, recently published), it is a physical phenomenon. Others regard coagulated casein as a lime salt, and certain others regard it as being less hydrated than casein in suspension, according to which the rennet would be a dehydrating diastase.

Rennet solutions are quite changeable. The action of the air is harmful; the rennet is oxidized, and its quality considerably lowered. The more concentrated the solution, the less changeable it is. A solution slightly acid keeps better than a neutral solution. In any case the solutions retrograde during the first months following their preparation; thus, the industrial rennets titrating 15,000 to 18,000 are lowered by 30 per cent in two months, according to Soxhlet.

The production of casein by means of rennet is almost exclusively reserved for the casein serving for the manufacture of cheese or other alimentary products; this coagulum retaining better than that due to the acids the mineral salts (phosphates) and the fatty matters in emulsion (cream).

I also recall the fact that casein has been employed as a substitute for albumen in the fixation of colors, and that enormous quantities are employed in the manufacture of common objects formerly made of ivory, bone, or ebonite.

Among other industrial applications are the production of sugar of milk, that of lactic acid and the lactates, and the manufacture of fermented drinks having milk as a base, such as kafir and koumis.

SUN SPOTS AND TERRESTRIAL MAGNETISM.—It has long been known from the researches of Balfour Stewart, Ellis and others, that there is a close connection between the times of occurrence of greatest sun spot frequency and largest amplitude of the diurnal inequality of magnetic declination and horizontal force. C. Chree has found that this relation can be represented by a simple equation of the form $Ra = b + S$, where S is the sun spot frequency, R is the mean monthly range or difference between the greatest and the least of the 24 hourly values in the mean diurnal inequality for the month in question, based on five selected "quiet" days, and *a* represents the amplitude of the range corresponding to the total absence of sun spots; *b* shows a very similar variation from winter to summer in all the three magnetic elements, as the following table of comparative values will show:

	Winter.	Equinox.	Summer.
Declination	79	117	134
Inclination	81	113	106
Horizontal force	85	116	99

For the declination, the absolute value of *a* in winter is 3'.23, and of *b* 0'.0323. Winter is the season when sun spot frequency is relatively most important, but the greatest absolute influence of sun spots is found at the equinoxes.—C. Chree, Proc. Roy. Soc., January 22, 1903.

* The composition of cow's milk is: Water, 86 to 92 per cent; butter, 2 to 5.6 per cent; casein, 3 to 5 per cent; sugar, 3 to 5 per cent; salt, 0.2 to 0.7 per cent. The principal salts are calcium phosphate 50 per cent, chloride of potassium 40 per cent, on the average.

[Continued from SUPPLEMENT No. 1436, page 23018.]

SOME DETAILS OF THE PARIS-MADRID RACING AUTOMOBILES.

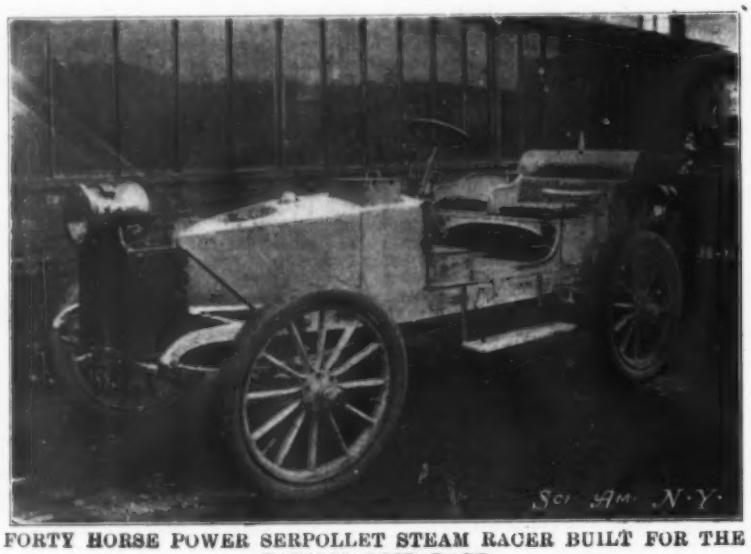
Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT by Our PARIS CORRESPONDENT.

III. THE SERPOLLET STEAM RACERS; DE DIETRICH HEAVY CAR; AND DARRACQ LIGHT-WEIGHT MACHINE.

THE new 20 and 40 horse power Serpollet steam racers, which were built specially for the Paris-Madrid event, present many points of interest, as their construction has been considerably changed from the preceding types. The motor has been shortened and made more compact, while retaining the essential features of the two steam cylinders on each side, with their inlet and exhaust valves at the outer ends and controlled by the long valve-rods which bear against the central cam shaft through rollers. The suspension arms of the motor are now spread wide apart, so as to give it a solid support, in view of the shocks which it is apt to receive on the road. The motor and the accompanying mechanism, instead of being mounted on a separate frame of special form as before, is now simply fixed to two I-beams running across the chassis, making a lighter construction. The motor of the 40 horse power machine has double the cylinder volume of the 20 horse power, using a 3.6-inch cylinder bore and a 5-inch stroke. The chassis of the racing cars are built of pressed steel in place of channel iron. The flash tubes of the boiler have been considerably increased in heating surface per element. A certain number of these elements are superposed to form the boiler, which is heated from below by a special oil burner. While the surface of the elements is increased, fewer of them are used, so that the boiler is now lower than before, which gives it a better shape. The boiler has two tubes for the water inlet instead of a single one, for while its normal output is 40 horse power, it may be called upon at certain times to give as high as 200 horse power, and the change must be made very rapidly. Hence the necessity of the double supply and the two pumps which feed the boiler. The latter is now mounted in the extreme rear of the car. The Paris-Madrid racers have been still further modified over the car which was used lately at Nice, as the position of the working parts is considerably changed. The exterior form of the car is also quite different, as the torpedo shape is no longer used. The engravings show the 40 horse power car with its pointed front, and the 20 horse power, which has a square build. Another view shows the chassis of the 40 horse power machine. Both the gasoline and water reservoirs are now contained in the front box. Under it is the set of copper tubes which forms the condenser, while the radiator is mounted in the front of the car.

One of the features of the racing machines is the new disposition which is adopted for operating the pumps which work together to feed the water to the boiler and the oil to the burner. The two pumps are worked by the same lever, so that the oil feed and, consequently, the heat of the flame, will always be proportional to the amount of water sent into the flash tubes. In the regular machines, the to-and-fro movement of the pumps is obtained by a set of eccentric disks mounted side by side on the same shaft. The set can be shifted back and forth so that any one of the disks can push the lever arm of the pump, and, as the disks are set at different angular positions, the stroke of the pump is varied accordingly. For the ordinary machines, five or six disks are enough to give all the different speeds which are required; but, as the motor is now much more powerful, the change from one disk to the next would be too abrupt, and so a great number of eccentrics would be needed to give an easy gradation. This would be too cumbersome, however, so an entirely different method is adopted, which gives a very light and compact mechanism. The principle is illustrated in the diagram, Fig. 1, in which *A* is the motor shaft, carrying the eccentric, *B*. The object is to give a to-and-fro movement to the roller, *C*, on the pump lever, by the rotation of the shaft, and, at the same time, to be able to adjust the length of the stroke by means of a lever. The eccentric carries a strap, *S*, which is connected below to a sector, *M*. The motor shaft also has a strap, *R*, whose outer end is pivoted to the sector at the upper part. Upon the strap, *R*, is mounted a rod, *q*, by which the sector can be shifted up or down. The sector presses against the roller, *C*, of the pump lever. By moving the rod, *q*, up or down, the sector is displaced more or less in the vertical direction, and the part which bears upon the roller will be shifted to the right when the sector is elevated and *vice versa*. Thus the position of the sector relative to the eccentric is adjusted, and a greater or less stroke is given to the pump. As shown in the diagram, the sector is in the position of zero stroke and the pump does not work. Upon lifting the rod, the pump commences to operate and the stroke is increased progressively up to the maximum. The second diagram, Fig. 2, shows the actual method of mounting. The motor shaft, *A*, carries the eccentric, *B*, while *k l* is the sector which operates the water and oil pumps, *P p*, by a common lever which carries the roller, *C*. The spring, *E*, keeps the roller always pressed against the sector. The upper lever, *R*, carries the rod, *q*, which is connected by the various lever arms, *o*, *n*, *m*, with the main lever, *B*, which the driver operates over a notched sector to obtain the different speeds of the car.

The De Dietrich cars now use the new system devised by Turcat and Méry, and although it has been in use for only a year or more it has already proved very successful. The fact that the new racing cars took such a high place in the race this year is certainly a new point in their favor. The characteristic of the new system lies rather in the number of improvements in the details, and especially the facility of inspection and repair, although it has several new features. The motor of the racing machines, which has two pairs of cylinders, gives 45 horse power. The position of the motor will be observed in the general view of the car. A cock at the top of each cylinder can be opened to make sure that the cylinder is giving its proper explosion, and can also be used to put in a small amount of gasoline in order to start the motor after long standing. On the side of the crank case are two large covers, one opposite each pair of cylinders, which can easily be taken off and the inside of the case inspected. In the regular model of this make, the inlet valves are automatic but in the racing cars the inlet valve is mechanically operated. The water jacket is cast with the cylinders, the whole forming an integral casting. The ignition current is generated by a magneto machine, which is operated from the motor and is bolted directly to the crank case, its gearing being contained in an oil-tight casing. The water is circulated by a small turbine pump driven by a chain, and also on the thermo-siphon principle. The



FORTY HORSE POWER SERPOLLET STEAM RACER BUILT FOR THE PARIS-MADRID RACE.

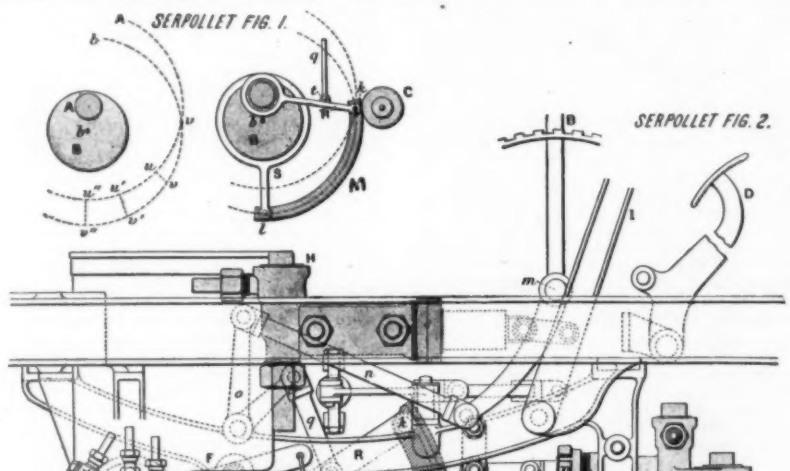
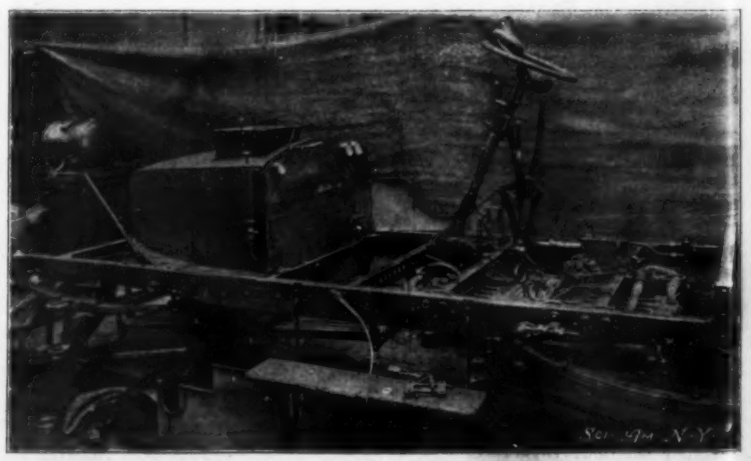


FIG. 1.—PUMP-CONTROLLING ECCENTRIC. FIG. 2.—METHOD OF MOUNTING. DETAILS OF THE SERPOLLET PUMP-OPERATING MECHANISM.

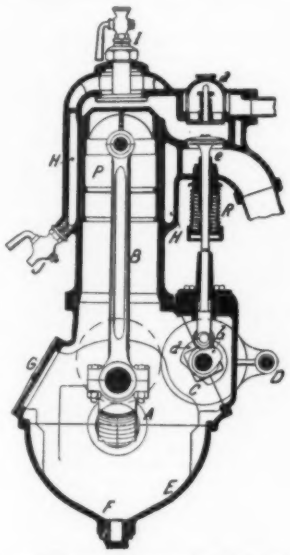
A TWENTY HORSE POWER SERPOLLET RACER BUILT FOR THE PARIS-MADRID CONTEST.



CHASSIS OF THE FORTY HORSE POWER SERPOLLET RACER.

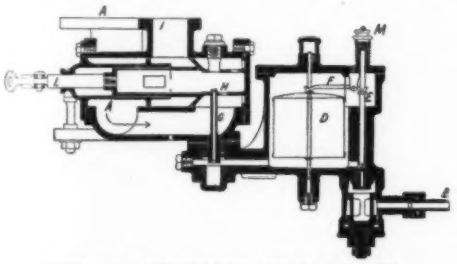
latter can be used if the pump should fail to work. The position of the radiator, which is placed directly against the pointed front, will be observed.

A carbureter of an improved type is employed, which is shown in section in the diagram. At *D* is the float-feed, but in this case it is not balanced by counter-weights, which are likely to change their position owing to the shocks of the road. The counterweights are therefore replaced by a spring, *M*, situated on the



THE DE DIETRICH MOTOR—CROSS-SECTION THROUGH CYLINDER.

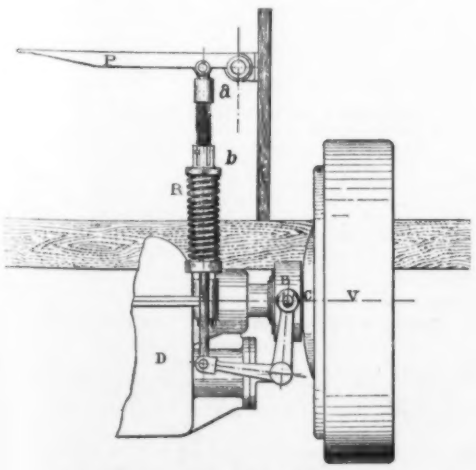
outside, which balances the weight of the float. By adjusting the spring, which can be done from the car, the action of the needle valve, *E*, is controlled, and a very close regulation can be obtained, which results in an economy of fuel. Another method of regulating the carbureter is by the action of the piston, *L*, which is generally connected with the ball governor of the motor, and, as it slides back and forth, stops more or less the orifice which leads from the atomizing nozzle, *H*, to the outlet pipe, *I*, above. This movement, however, can be controlled independently by a



THE DE DIETRICH CARBURETER.

separate lever, by moving which the driver can cut down the supply of gas to the motor. Thus the speed can be considerably changed while still running on the high gear, by throttling the gas supply and varying the ignition.

The other diagram shows a section of the friction clutch. The clutch has been considerably improved in detail. The cone, *B*, of the clutch turns loose on the shaft, and is slid back and forth by a fork working on the collar, *C*. Should the spring of the clutch break, in most cases it is a long operation to replace

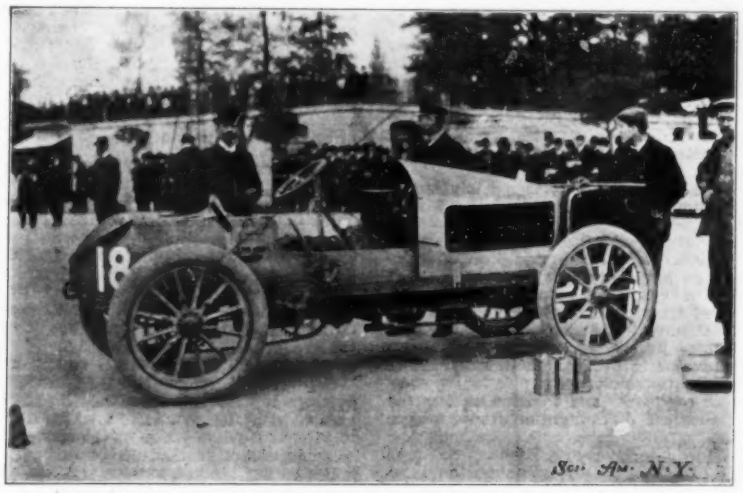


THE DE DIETRICH CLUTCH.

it. The inventors have overcome this difficulty by placing the spring at the top, at *R*, where it is only necessary to lift up the flooring, detach the pedal, *P*, from the rod, unscrew the two nuts, *a* and *b*, and put on a new spring. The speed changes are made by a set of gears, which are slid along on the lower shaft by means of the speed lever, so as to bring them into mesh with the various gears of the upper set, mounted on the other shaft that drives the differential. The reverse is obtained by interposing an intermediate pinion between the driving pinion and the slow-speed gear wheel in the regular manner.

The De Dietrich car shown herewith, driven by Mr. Stead, collided with another racer while trying to pass it. Stead was badly injured, and his mechanic was instantly killed. Charles Jarrott, on another De Dietrich car, the first machine to start in the race and the fourth to finish at Bordeaux, we illustrated in June 20. Mme. Du Gast drove a third De Dietrich car.

While the cars in the heavy-weight or regular automobile class are allowed a maximum weight of 2,200 pounds, the light-weight class includes the cars weighing between 880 and 1,430 pounds. A good example



AT THE WEIGHING GROUNDS. ONE OF THE WINNING DE DIETRICH CARS.

of the light-weight car is the Darracq, which was one of the winners in the Bordeaux stage. Our view of the Darracq racer shows the complete machine with the bonnet removed. The motor is built for 45 horse power, and has four cylinders mounted in pairs upon the crank case. Both inlet and exhaust valves are operated mechanically by a cam shaft inside the motor case. The exhaust valves are on the outside of each pair of cylinders and the four exhaust pipes pass down vertically to a cylindrical muffling box. Between the exhaust valves are the two inlet valves; each pair is supplied by an inlet pipe which passes over the top of the motor to the rear, where the two pipes join on to the tube leading to the carbureter, which has a valve for controlling the gas supply. The carbureter is of the float-feed and atomizer pattern, and is designed so that the quantities of gasoline and air for the explosive mixture are automatically proportioned to secure a maximum efficiency whatever may be the speed of the motor. In the racing machines, the motor can make from 100 to 1,500 revolutions per minute. The water-jackets are cast in the same piece with the motor cylinders, and the water pump chamber is cast with the crank case. The diagram of the motor shows the disposition of the pump, which is of the sliding vane type, with its outlet pipe shown at *D*. The pump is fitted with a filter to remove the impurities. One feature of the Darracq machine is that the motor, pump, and ignition apparatus form a compact piece, which may be detached from the chassis by simply taking off four bolts, without disturbing the remaining parts. Difficulties due to the ignition have been avoided as much as possible by making the ignition system very compact and placing all the parts near each other and within easy reach. The batteries and spark coil are mounted quite near the spark plugs, which diminishes the length of wire and hence the troubles from this cause. The radiator is placed quite close to the motor; it is of the wing tube type and built very compact. The water pipes leading to the motor from the radiator are made as short as possible to avoid breaking. In the rear of the motor are the flywheel and friction clutch mounted together, then a short piece of shaft connects to the change-gear box, which is of the sliding gear type, giving three speeds and reverse, and does not present any special features, except that at the highest speed the motor shaft is locked directly with the shaft of the differential and drives it without the use of gearing. The movement is transmitted from the gear box to the differential by a straight shaft with universal joints. The differential is of an improved design. The rear axle of the car turns in a tube, each side of which is joined to the differential case in the center. The jointed driving shaft, coming from the gear box, terminates in a pinion, which engages with a large bevel gear on the differential. The side thrust of the pinion upon the gear, which is unavoidable with a bevel gear drive, is taken up by a ball-bearing. The entire rear axle is mounted on ball bearings, and the differential and driving gears are all in a tight case made in two halves and filled with lubricating grease. The brakes of the racing car are specially improved and are entirely metallic. The pedal brake, which operates on the differential, is likely to heat up in going down long grades, owing to its high speed, and a new form of brake is used here, working upon a drum which is kept cool by a water circulation from the pump. The motor is lubricated by an oiler, but all the other parts of the mechanism work in consistent grease and require no attention. The oiler for the motor is a new feature. It is automatic, and the supply of oil is assured by connecting the oil tank with a water pressure from the main pump. The oiling thus commences with the first few turns of the motor, and ceases when the motor stops, and the supply is kept proportional to the motor speed. The Darracq racer was one of the few to run with alcohol, using a mixture of half gasoline and half alcohol.

DARRACQ LIGHT CAR.

DIRECT PRODUCTION OF X-RAYS IN THE AIR.

EXPERIMENTS have proved to me that X-rays can be produced *directly in the air* (without having recourse to the Crookes vacuum) originating under the simultaneous influence of *ultra-violet* rays and of an *electric field*.

If such a field is created between the two armatures of an air condenser, and a pencil of ultra-violet radiations is directed on one of the armatures, there is a production of X-rays.

These rays are propagated in the same direction as the lines of electric force of the field. They are not emitted in other directions. They have a greater activity when the direction of the lines of force is the same as that of the propagation of ultra-violet rays; that is, when the illuminated armature is of negative polarity.

The activity of the emitted X-rays is then dependent on the intensity of the electric field, on the intensity of the ultra-violet rays, on the wave length of these, and lastly on the nature of the substances in the surface of which they originate.

The general properties of X-rays produced directly in the air are identical with those produced by means of the Crookes tubes.

They discharge the substances electrized after their passage through aluminium and black paraffined pasteboard. They possess photogenic properties. The ultra-violet rays which serve to produce these rays can be obtained from different sources, such as the electric

spark, the electric effluvium, the ordinary voltaic arc, and lastly the voltaic arc produced between two graphite pencils furnished with aluminium cores.

The electric charge of the field was obtained by means of a small electrostatic machine. The measures were made by a special single gold-leaf electrometer inclosed in a Faraday cage. The instruments were in darkness to avoid the actinic action of the external luminous rays.

A first series of researches was effected by the following arrangement:

A thin aluminium leaf closed the central opening of a disk of black paste-board. A metallic plate with a smaller diameter than the disk was placed parallel at a distance varying from 10 to 30 centimeters. The whole of the apparatus was insulated. The leaf of aluminium and the metallic plate formed the two armatures of a plane condenser. The source of the ultra-violet radiations was arranged before the aluminium leaf. This formed a screen to the radiations.

In charging the condenser and in illuminating the external surface of the aluminium, the production of the X-rays was effected on the interior surface of this metal.

The activity of the rays produced was sensibly diminished in consequence of the passage of these rays through the aluminium.

A second arrangement avoided this cause of diminution. This was composed of an insulated sheet of aluminium, inclined at an angle of 45 deg., on a pencil of ultra-violet rays. A conductor, connected with the earth, was sheltered from the light, at about 30 centimeters from the illuminated face of the aluminium. The ensemble formed by the insulated leaf of aluminium and the conductor in the ground was capable of realizing an electrostatic condenser.

In charging this condenser and in illuminating the interior face of the leaf of aluminium, there was a production of X-rays.

Under these conditions the propagation of the rays was effected, according to the deviation of the lines of force of the field.

As the rays did not have to traverse the thickness of the aluminium, they possessed greater activity than in the preceding experiments.

The *actino-electric* phenomena seem to find their explanation in the direct production, in the air, of X-rays, under the double influence of ultra-violet radiations and of an electric field.—From the French of M. A. Nodon. Paper presented to the Académie des Sciences.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Steamship Service with Copenhagen and Baltic Ports.—The new 10,000-ton steamship "United States" left Copenhagen June 3 for New York on her first trip. The "United States," like her sister ships, "Heilig Olav," which is now on her maiden voyage to New York, and "Oscar II.," which was put into service in 1902, is a well-equipped, modern steamship. She accommodates 131 first-cabin, 76 second-cabin, and 1,302 steerage passengers, or a total of 1,509. Her gross tonnage is 10,085; net tonnage, 6,019; horse power, 8,350; and speed, 15 knots. She is 500 feet long, 58 feet wide, and 41 feet deep.

These vessels are important additions to the list of passenger and freight steamers plying between Scandinavian and United States ports. Each has more than twice the net tonnage capacity of any other steamer in this trade.

The United Steamship Company (Det Forended Dampskibs-Selskab) of Copenhagen, for which the new steamships were built, owns, in all, 127 steam vessels, of 156,483 gross tonnage. Of this number, 17, with 73,500 tons, are engaged in the trade with the United States. The three ships already mentioned, together with the "Norge," "Hekla," and "Island," of 3,300, 3,200, and 2,800 tons, respectively, constitute what is popularly known as the "Scandinavian-American Line." Their terminal points are Copenhagen and New York, and they touch at Christiania and Christiansand, in Norway. Other steamers run from Copenhagen to New York, as well as to Boston and New Orleans.

The company maintains regular connections with practically all European ports. Especial attention is given to the Baltic Sea trade, although conditions do not yet warrant direct service from the United States to far eastern Baltic ports. It is but a matter of time, however, when a regular line of steamers will be established. At present quantities of freight are transferred at Copenhagen from the trans-Atlantic steamers of the company to other vessels which run to Baltic ports.

American exporters appreciate that success in holding and extending foreign markets depends to a considerable extent on ocean transportation facilities. Copenhagen, with its admirably conducted free harbor and extensive shipping interests, is destined to be reckoned among the world's greatest distributing centers. The Danes are not only consumers of our products, but they act as intermediaries in a large way for American goods of every description. Our manufacturers and exporters should recognize the promising conditions here and take advantage of them.—Raymond R. Frazier, Consul at Copenhagen.

Proposed German Tariff on Machinery.—The following has been received from Consul J. F. Monaghan, of Chemnitz:

As always happens in a country when the revision of its tariff has been consummated, all parties are not content and strong opposition develops. Chemnitz papers, assuming spokesmanship for the great machine interests of the city, express dissatisfaction with the duty upon machinery. It is contended that not only is the new tariff entirely out of keeping with the high duties imposed upon machinery by other countries, but it also fails to maintain a proper relation between the duty upon the raw materials used by machine builders and that upon finished machines.

As to the comparative amount of protection offered by the German tariff and that of other nations with which the German Empire enjoys a good export trade in machinery, it is demonstrated that while the new German tariff incorporates a duty of from 3 to 5 per cent, and, in some cases, even as low as 1½ per cent, the American duty averages 45 per cent, while Austria recently raised her duty about 20 per cent, and with certain classes of machinery more than tripled it. Russia, also, has almost doubled her duty on machinery.

The comparative lowness of the German tariff is considered a most serious menace to the machine-building industry of the country. It is urged that the present tariff be amended so as to provide the country with an effective weapon for the conclusion of reciprocity treaties with other nations. The new Austrian tariff, it is believed, will seriously injure the export trade of Germany to that country, which, in 1901, amounted to the considerable sum of $4,300,000 for machinery and parts of machines. Austria, it is reasoned, has put on her armor in anticipation of commercial wars.

How far these sentiments find support at Berlin is unknown; but since the publication of the new tariff in its final form, criticisms seem to have been strengthening, so that the possibility of more material influence leading to a revision of the present machine duties is by no means precluded.

American Dried Fruits in Germany.—While in the United States last year, I visited a number of the larger prune and apricot orchards in the vicinity of San José, Cal., and since my return to this country have given the importation of evaporated American fruits considerable study. For this part of Germany—namely, Baden and Alsace-Lorraine—I find the outlook for increased sales most encouraging. From the leading importer in the western part of Germany I learn that California prunes and apricots are rapidly supplanting the products of France and Italy. The California fruit is cheaper and its flesh brighter and more solid.

Speaking of the packing and drying of prunes and apricots, my informant tells me he has no fault to find, except with the manner in which the boxes are put together. He says there would be less breakage if they were dovetailed instead of being simply nailed.

Regarding the time in transit, he says that he has experienced considerable annoyance and some loss of trade in consequence of shipments being delayed *en route* from California. One shipment was over ten weeks on the way; the buyers think the goods were held in New York several weeks. California fruits are generally paid for in advance, which fact makes delays in shipment especially annoying.

The Elsässische Conserven-Fabrik und Import Gesellschaft, of Strassburg, last season sold 8 carloads of apricots, 10 carloads of prunes, and 25 carloads of evaporated apples. Prunes and apples retail here at from 12½ to 15 cents per pound and apricots at 20 cents.

The evaporated apples come from the vicinity of Rochester, N. Y., and find a ready sale. Considerable fault, however, was found with the shipments of last season. The apples were not all sufficiently dried before packing, which caused them to mold in the boxes. The metric system should be used in foreign shipments. —Joseph I. Brittain, Consul at Kehl.

New European-Mexican Steamship Lines.—The Hamburg-American Line has inaugurated a special fast freight and passenger steamship service between Hamburg and Veracruz, via Havre, Corunna, Habana, and Tampico. The vessels range in tonnage from 5,600 to 6,030 tons, are furnished with quadruple-expansion engines, and have an average speed of from 13½ to 14½ knots. They are provided with modern conveniences and have been specially fitted with a view to the comfort of passengers in the tropical service. The largest vessel of the fleet of three will draw, when fully loaded, 24 feet.

The service is monthly; a vessel leaves Hamburg on the 26th of the month, Havre on the 29th, Corunna on the 1st of the following month and arrives at Habana on the 14th and at Veracruz on the 17th, where it will remain about a week. It then proceeds to Tampico, arriving on the 25th. On the 29th the boat leaves Tampico on her return trip, leaving Veracruz the 1st of the succeeding month and Habana on the 5th, arriving at Corunna on the 18th, at Havre on the 20th, and at Hamburg on the 24th, making the round trip in about two months.

Another new steamship line, to be known as the Austro-American, has recently been established by the Austrian Lloyd, of Trieste, for service between Adriatic, Mediterranean, and Mexican Gulf ports. The Lloyd Company, which operates a fleet of 20 steamers, intends to have a monthly service of steamers ranging from 3,550 to 6,400 gross tons each. No time-table has yet been issued, nor is it possible at present to obtain freight and passenger rates.

The first vessel to arrive at Veracruz was the steamship "Anna," of 3,550 tons, which left Trieste March 10, calling at Genoa, Marseilles, Barcelona, Tampico, and Veracruz; on the return voyage touching at Progreso. The company advertises to receive freight from Mexico for Trieste and Mediterranean ports; also cargo for ports on the Continent, with transshipment to other vessels of the same line at Curaçao.—W. W. Canada, Consul at Veracruz.

Tax on Dynamite and Powder in Mexico.—Under date of June 8, 1903, Consul W. W. Canada sends from Veracruz copy (printed) of a decree relating to the manufacture of smokeless powder and dynamite in Mexico,* as follows:

"Article 1. The Executive is empowered in accordance with the contract entered into by the Department of Fomento with the Compañia Nacional de Dinamita y Explosivos, S. A., to establish an internal consumption tax on all kinds of dynamite and industrial explosives imported from abroad or manufactured in the Republic, said tax to be payable when and as the Executive may determine.

"Article 2. The basis for the creation of said interior consumption tax will be as follows:

"I. Dynamite and industrial explosives, entered through the custom-houses of the Republic, will pay $210 ($94.50 gold) per ton of 1,000 kilogrammes (2,204 pounds) gross weight.

"II. Exemption from said tax may be allowed in the case of common gunpowder, black gunpowder for mines and gunpowder for fireworks or for hunting purposes in the composition of which the only ingredients used are sulphur, carbon, and the nitrates of soda and potash, and not nitroglycerin, chlorate of potash, or other chemical explosive.

"III. The Compañia Nacional Mexicana de Dinamita y Explosivos, S. A., will pay the internal consumption tax on the products which it may manufacture, in the form and subject to the conditions provided by the contract which it made with the Department of Fomento on August 12, 1901."

Commercial Policy of Hungary.—Consul F. D. Chester reports from Budapest, May 23, 1903:

It is reported that Hungary intends to impose countervailing duties on American manufactured goods, or at least to demand the termination of the commercial treaty of 1829 and the substitution of a reciprocal in place of a most-favored-nation convention, similar to that concluded by the United States with France.

The export of sugar from Hungary to the United States ceased last year. In concluding a reciprocity treaty with the United States, Hungary will lay more stress on her export of glassware, majolica, hand embroideries, bent-wood furniture, rubber toys, tobacconists' ware, etc., than on the articles paying specific duties, viz., mineral water, wine and brandy, beans, tobacco, and wool. It is to be feared that the United States will have difficulty in securing tariff rates as low as those now prevailing under the favored-nation clause, or as low as those granted to the manufactures of Germany and Switzerland.

New Freight Railway in Germany.—Consul B. H. Warner, of Leipzig, June 4, 1903, writes that the Prussian government has granted a franchise to a joint-stock company to build a freight railroad about 3 miles long from Mühlberg, on the Elbe, to Burxdorf, on the main line of the Berlin-Riesa-Dresden Railway. The estimated cost of the roadbed, exclusive of the ground—which has been donated by the city of Mühlberg—is 625,000 marks ($148,751). It is claimed that the new line will considerably increase the importance of Mühlberg as a river port, by diverting a portion of the traffic between Hamburg and points in central Germany in the vicinity of the Elbe River.

Mexican Tariff on Ferromanganese.—Consul W. W. Canada reports from Veracruz, June 8, 1903:

The Mexican government has reduced the import duty on ferromanganese with the view of encouraging the manufacture of steel by modern methods in the Republic. Ferromanganese containing 25 per cent or more of manganese was formerly subject to a customs duty of $5 per 100 kilogrammes (5 cents silver, or about 2.25 cents gold, per 2.2 pounds) gross weight; the new rate of duty has been fixed at $1.50 per 100 kilogrammes (1.5 cents silver, or 0.67 cent gold, per 2.2 pounds) gross weight.

Failure of Corn Crop in Yucatan.—Consul W. W. Canada, or Veracruz, under date of June 8, 1903, says that recent reports from Yucatan indicate a failure of the corn crop of that section. A certain disease is destroying the corn in the fields, and all the efforts of the agriculturists have been powerless to stamp it out. A shortage of supply, the consul notes, should be expected from that region for the coming season, and it would be well for our exporters to keep a close watch on that market.

Condition of German Jute Industry.—Under date of May 29, 1903, Consul T. J. Albert, of Brunswick, reports:

The Union of the German Jute Industry was organized to establish an equilibrium between the demand and the production of the jute factories. For this purpose, the union has in the last two years put out of service 22,830 spindles and 1,148 looms. Many members of the union have also voluntarily put out of service 4,110 spindles and 247 looms, so that the reduction amounts to 26,940 spindles and 1,395 looms, or more than 20 per cent of the entire number in the union. In spite of this, there exists to-day a large overproduction of jute in Germany.

Concession to Manufacture Soap and Candles in Honduras.—Consul William E. Alger, of Puerto Cortes, informs the Department, June 10, 1903, that the Congress of Honduras has granted a concession to an American citizen to manufacture soap and candles, with the privilege of importing all raw material duty free for a period of ten years.

Alkali Discovery in Germany.—Consul B. H. Warner writes from Leipzig, under date of May 28, 1903, that new alkali deposits have been found in the province of Saxony, Germany. Test holes were bored by the Grossesterhausen sugar factory and by the Prussian government, with the understanding that the first to strike alkali deposits was to have the option on a tract of 568 acres. The results have shown that a new field of considerable commercial importance will soon be opened.

* Advance Sheets to No. 1,242 (January 18, 1902).

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1684, June 29.—*Steamship Service with Copenhagen and Baltic Ports—*Proposed German Tariff on Machinery—*Condition of German Jute Industry—*Concession to Manufacture Soap and Candles in Honduras—Power Plant in Saxony—City Employes in Leipzig.

No. 1685, June 30.—*American Dried Fruits in Germany—*International Competition in South American Markets—*Commercial Policy of Hungary.

No. 1686, July 1.—Mining in British Columbia.

No. 1687, July 2.—*New European-Mexican Steamship Lines—*New Freight Railway in Germany—*Mexican Tariff on Ferromanganese—*Failure of Corn Crop in Yucatan—*Tax on Dynamite and Powder in Mexico—*Mexican Commercial Museums Abroad.

No. 1688, July 3.—Petroleum Industry of Roumania—Tariff Changes in Norway—Closing of Venezuelan Custom Houses.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

TRADE NOTES AND RECIPES.

Repairing Rubber Water Bottles.—We have known individuals to satisfactorily repair rubber water bottles with the ordinary outfits employed to mend punctures in pneumatic bicycle tires. This treatment, of course, is on the assumption that the bottle is not too far beyond redemption. Another expedient is to paste over the break a strip of adhesive plaster, and the scheme works very well.—Pharm. Era.

White Stamping Ink for Embroidery.—

Zinc white	2 drachms
Mucilage	1 drachm
Water	6 drachms

Triturate the zinc white with a small quantity of water till quite smooth, then add the mucilage and the remainder of the water.—Drug. Circ. and Chem. Gaz.

To Prevent Smoke from Flashlight.—To prevent the smoke from magnesium ribbon or powder from spreading throughout the room, support over the point where the ignition is to take place a large flat pad of damp wool lint. This may be done by tacking the lint to the underside of a board supported on legs. When ignition takes place, the products of combustion for the most part will become absorbed by the wool.—Drug. Circ. and Chem. Gaz.

Colors from Petroleum.—It is reported from Russia that a factory at Kineshma has succeeded in producing faultless aniline colors from petroleum, such as have heretofore been obtained from coal tar. The dyes derived from petroleum are free from tiophene and do not assume a greenish hue in time. The said factory is now producing annually 50,000 pounds of such dyestuffs which are mostly employed for dyeing cotton goods.—Oesterreichische Chemiker und Techniker Zeitung.

Cleaning Copper Sinks.—Make rottenstone into a stiff paste with soft soap and water. Rub on with a woolen rag, and polish with dry whiting and rottenstone. Finish with a leather and dry whiting. Many of the substances and mixtures used to clean brass will effectively clean copper. Oxalic acid is said to be the best medium for cleaning copper, but after using it the surface of the copper must be well washed off, dried, and then rubbed with sweet oil and tripoli or some other polishing agent, otherwise the metal will soon tarnish again.—Pharm. Era.

Spot Removers for Oil and Grease Stains.—

I.

Soap spirit	100
Ammonia solution 10 per cent	25
Acetic ether	15

II.

Benzine	200
Ether	40
Acetic ether	30
Oil of turpentine	60

—Pharmaceutische Post.

Coloring Unpolished Brass.—A yellow color of handsome effect is obtained on unpolished brass by means of antimony chloride solution. The latter is produced by finely powdering gray antimony and boiling it with hydrochloric acid. With formation of hydrogen sulphide a solution of antimony chloride results, which must not be diluted with water, since a white precipitate of antimony oxychloride is immediately formed upon admixture of water. In order to dilute this liquid, completely saturated cooking salt solution is employed, using for one part of antimony chloride two parts of salt solution.—Metallarbeiter.

Bernhard, a German experimenter, noting the structure of aluminium, concluded to try it for putting an edge on fine cutting instruments such as surgical knives, razors, etc. To his surprise and pleasure, it acted exactly like a razor hone of the finest quality. Further investigation showed that the metal had other characteristics that made it pre-eminently useful in this direction. When steel is rubbed on it, as for instance, in honing a knife blade, the metal disintegrates, forming an infinitely minute powder of a greasy unctuous feeling that clings to steel with great tenacity and thus assists in cutting away the surface of the harder metal. So fine is the edge produced that it can in no wise be made finer by the strop, which used in the ordinary way merely tends to round the edge. The writer of the paragraph has confirmed most of Bernhard's statements, though he believes that he can get an edge with the Ouachita (Hot Springs) hone equally as fine as aluminium gives, and equally as rapidly.—Nat. Drug.

Ice Cream.—

Strawberry.

Strawberry juice	1 quart
Cream	4 quarts
Sugar	2½ pounds

Banana.

Bananas	6 or 8
Cream	5 quarts
Sugar	2 pounds

Press the bananas through a sieve, dissolve the sugar in the cream, stir in the bananas, and freeze.

Peach.

Peach juice	1 pint
Cream	2 quarts
Sugar	1 pound

Lemon.

Lemons	4
Cream	4 quarts
Sugar	2 pounds

Rub the rinds of the lemons with lumps of hard sugar until the flavoring is transferred to the sugar. Dissolve this with the remainder of the sugar, strain if necessary and begin to freeze. When nearly frozen add the juice of the lemons. It is said that if added sooner the cream is liable to be curdled.

Orange.

This is made by taking two oranges and one lemon, and then proceeding as above.—Drug. Circ. and Chem. Gaz.

ENGINEERING NOTES.

To figure out the power required to hoist a load up an inclined plane, the first thing is the load on the engine. In an inclined shaft, 200 feet long and with a vertical depth of 150 feet, multiply the weight of ore, car and rope in pounds by the depth of the shaft in feet and divide by the length; weight 2,000 pounds; $2,000 \times 150 = 300,000 \div 200 = 1,500$ pounds, the weight on the engine. The horse-power is found by multiplying the weight in pounds by the speed of hoisting in feet per minute and dividing by 33,000. If the load is lifted at 200 feet per minute in the example, $1,500 \times 200 = 300,000 \div 33,000 = 9.1$ horse-power. To allow for friction, etc., add one-third, making 12 horse-power.—Mining and Scientific Press.

A series of experiments were recently made in the Electrical Laboratory of the Case School of Applied Science to ascertain the electrical resistance of oils as affected by temperature and impurities. The results of these tests were given by Prof. J. W. Langley in a recent issue of the Electrical World and Engineer. The conclusions arrived at are: (1) That at ordinary temperatures the resistance of oils is extremely high; (2) that in order to have a high resistance the oil must be pure; (3) that the resistance grows less with the per cent of impurity; (4) that, within the limits of these experiments, the resistance is mainly of the nature of a contact resistance, and varies but slightly with change of distance between electrodes; (5) that the resistance is not a direct function of the temperature, though it varies inversely with it in a general sense; (6) that for temperatures above that at which marked decomposition of the oil sets in (150 deg. C.) the resistance is practically constant, or approaches a constant.

That a given amount of metal arranged in the form of a tube will be stronger than a solid bar has long been known. The principle was long ago utilized in the formation of the square columns of steel frame buildings. Lately it has been applied to the immense shafts of ocean steamships, which are subjected to severe bending as well as twisting strains. A hollow shaft is stiffer than a solid one of the same weight. The most recent use of the idea is in the manufacture of axles for cars. A large number of hollow axles have been made in one of the shops of the Carnegie Company, at Pittsburg. It is asserted that less metal is used in them than in the ordinary axle. They also require much less machine work to finish them. From the manufacturer's point of view, at least, they are more satisfactory than those which they are designed to replace. Just what service may be expected of them is another question. In order to settle the question, a lot of cars are now being built with hollow axles under one truck and solid ones under the other. These are to be run for six months and then examined for signs of wear.

The development and expansion of the railroad system of Rhodesia, British South Africa, to facilitate the opening of the country, is to be carried out as rapidly as possible. The British South Africa Company has decided to expend $10,000,000 in this direction by providing cheap and rapid transport. Of this sum $5,000,000 is to be expended immediately, upon the construction of the Cape to Cario Railway up to the Victoria Falls, and the erection of the steel bridge which is to span the Zambesi at this point; the relaying of the Vryburg-Mafeking line with rails uniform with the rest of the Rhodesian railroads; the construction of a branch line from Gwelo to Oelukwe, a distance of twenty-five miles; a branch from Bulawayo to Gwando, one hundred miles; a branch from Salisbury to Gwelo, thirty miles; and extensive improvements on the Beira-Umtali section near Fontesvilla, in order to strengthen that line against the annual floods which have in the past greatly interrupted traffic. By the end of 1903 the second quota—$5,000,000—will be sanctioned for the purpose of carrying the Cape to Cairo line north of the Zambesi to the bend of the Kafue, a distance of three hundred miles, in which region very extensive discoveries of copper, lead, and zinc have been made. When these projected works have been carried out, Rhodesia will have over 2,500 miles of railroads.

Now that Great Britain has completed the laying of the all-British cable, linking the various colonies with the mother country, with a line that passes only through British possessions, the governments of Holland, France, and Germany are rapidly pushing ahead with similar State-aided schemes for connecting some of their possessions in the East Indies and elsewhere, in such a way as to avoid the necessity of passing over lines owned by British companies. These cables are as follows: A. France. Tamatave to Reunion, 460 miles; Reunion to Mauritius, 150 miles; Brest to Dakao, 2,415 miles. B. France and Holland. These countries in conjunction have agreed to lay a cable between Cochin China, Pulo Condor and Dutch Borneo, a total of 810 miles. C. Germany and Holland. Germany has undertaken to lay a cable from Dutch Borneo to the Celebes Islands, a distance of 390 miles. Holland is to furnish this section of the cable, but the two governments will carry it from the Celebes to the Pelew Islands, thence to Yap, and from that station to some point in connection with the American Pacific cable which is now being laid. The whole length of this connection will be 1,680 miles, and the two governments will jointly subsidize it to the extent of $350,000 a year. By this means Germany will be provided with an eastward cable route across America to New York, where it will join the German Atlantic cable lines. According to the statistical report issued by the Treasury Bureau at Washington on the subject of the world's telegraphs, there are in the world 1,750 submarine telegraphs, with a combined length of 200,000 miles, representing an aggregate cost of $375,000,000. In the year 6,000,000 messages are flashed across them. The total mileage of all telegraph lines is estimated at 1,180,000,000 miles, and the messages sent over them in the year 400,000,000. The longest stretch of European-American cable is that from France, which is 3,250 miles. In passing from Hayti to the Windward Islands the cable lies in 18,000 feet of water.

ELECTRICAL NOTES.

Jorgen G. Maardt, an engineer of Copenhagen, has brought out an invention which relates to the manufacture of an improved insulating material suitable for insulating boilers, steam pipes, and other heat-insulating purposes, and for electrical insulating purposes. The improved material is made principally from cork dust or cork waste, peat dust or small peat, or like material, mixed with waterglass and subjected to a hardening treatment. Besides being a good insulator, the improved material has the additional advantage of being incombustible and insoluble in hot or cold water or steam. In the manufacture of this material the inventor takes cork dust, cork waste, peat dust, small peat, or like material, and saturates it with waterglass. The resulting mass is then poured into molds, and subsequently boiled in a solution of chloride of calcium, calcium, chloride of magnesia, or other chloride salt or salts. This has the effect of hardening the mass. The hardened mass is then washed or rinsed in water to remove any chloride of soda which may be produced during the hardening operation.

Mr. E. Rutherford and Miss H. T. Brooks have compared the radiations of different radio-active substances. They state that the more penetrating β-radiation from uranium is deflected by a magnet, the deflection being of about the same order as for radium rays. The α-radiation is not affected by a magnetic field. The coefficient of absorption of β-rays by various metals has been determined, and it is found that the law of the absorption of cathode rays depending only on the density is not true for all substances. The most penetrating rays are the excited radiations due to thorium and radium, then follow in order the rays from thorium, radium, polonium, and uranium. In seeking for a connection between absorption and density, it has been found that when aluminium and air are compared, the absorption is proportional to the density. The result for the non-deviable rays is opposite to that for the deviable β-uranium rays. The emanating power of radium is increased more than 10,000 times by heating to dull redness. From the rate of leakage from excited radio-activity, it is deduced that the speed of formation of ions by this is greater than by the direct radiation. The penetrating power of radium-excited radiation is independent of the substance in which it is produced. The decay of excited radio-activity has been found to be a function of the time of exposure.

The Elektrochemische Zeitschrift contains a useful reference article by Dr. H. Lienau on bauxite. This mineral is the chief source of the commercial aluminium produced by the electrolytic processes, and although many attempts have been made, and are still being made, to replace it by some cheaper raw material, these attempts hitherto have been unsuccessful. Natural deposits of bauxite occur in France, Germany, Ireland, and the United States, those of the department Var in southern France being at present the most extensively worked. In 1896 the district produced 29,620 tons, and in 1901 65,000 tons, of which total 55,000 tons were exported to other countries. After a reference to the geological formation in which bauxite occurs and to the varying composition of the deposits, the author describes the various processes which have been worked at one time or another for extracting aluminium or its compounds from this source. The first patented process dates from 1858, and had for its object the extraction of aluminium hydrate from red bauxite. The demand by paper and color manufacturers for a cheaper source of aluminium sulphate than the alums turned attention to the direct production of aluminium sulphate from bauxite, but the efforts to produce this salt, free from iron, from red bauxite have not been completely successful. The utilization of bauxite for the electrometallurgical production of aluminium is a comparatively recent development, but very large quantities of the mineral are now being used in aluminium reduction works. The author surmises from this fact that bauxite is being employed directly in the electrolytic baths, and that the troublesome and costly process by which alumina was first extracted from the raw bauxite is now being dispensed with.

Some interesting details relating to the recovery of tin from tin-scrap have recently been published in the Zeitschrift f. Elektrochemie. In Germany, several works have been built and operated for carrying out this procedure, the largest of these being that of Goldschmidt, at Essen, where 50 to 60 tons of tin-scrap are reported to be treated per day. The difficulty of obtaining an adequate supply of raw material has hindered the development of other works, and the anonymous writer of the article we are discussing hints that the supply of tin-scrap is monopolized by one or two of the larger works. The processes used for recovering the tin are based upon the use of the scrap as anode material, in a bath containing sodium chloride and hydrate, or in one containing hydrochloric acid. The advantage of the former is that less iron goes into solution, but against this there is the lower efficiency of the process and the more spongy nature of the deposit obtained at the kathode. The failure to produce directly metallic tin is one of the chief difficulties in the operation of both processes, for considerable losses occur in smelting and refining the spongy deposit obtained at the kathode. Under certain conditions, metallic tin can be obtained in the electrolytic bath, and Pfanhauser, in the issue of the Zeitschrift f. Elektrochemie for January 16, has stated his opinion that the avoidance of formation of sponge is simply a question of maintaining the *concentration of the tin salt solution* in the neighborhood of the kathode. This condition would appear to be difficult to attain in the works treating tin-scrap on an industrial scale, and the problem of producing metallic tin at the kathode is complicated further, by the slow but gradual increase of impurities in the electrolyte. A new works for the treatment of tin-scrap has recently been built at Pfaffstätten, near Vienna, and an electrolytic process for recovering tin from slags is also reported to be in operation at Tostedt, in Germany.

A SIMPLE CIRCULAR COMPUTING SCALE.*

By JAMES ALEX. SMITH.

IT is not necessary to emphasize the utility of mechanical aids to computation in modern engineering practice. Although for some purposes calculating machines are almost indispensable, yet much routine work can be more expeditiously dealt with by applications of the slide-rule methods, provided a sufficient approximation to accuracy is attainable, a result not always following the use of the less complex commercial scales reading to one part in one hundred only.

The writer some years ago constructed a very satisfactory instrument of the circular scale type, requiring for its production, chiefly, a comparatively moderate acquaintance with the use of the dividers and drawing-pen. Three figures are significant, that is, the results as read, are correct to one part in one thousand, but, by estimating the fourth figure, possible error may be confined within still smaller limits. Operations in multiplication, division, reciprocals and logarithms may be effected; a number may also be raised to the square, cube, or other power, or any root may be found.

Of course, a well-constructed slide-rule, if of sufficient length, would have an equal scope, but to read to three figures there must be at least 1,000 graduations, the smallest less than 1-2,000 of the aggregate. Since the minimum space readily recognizable is about 1-50 inch, it follows that such a scale must have a length of at least 40 inches, and in the straight rule the necessity of carrying forward the results requires the duplication of the series, which would then become 80 inches long, or when the adjacent scales are fully extended, 160 inches, a prohibitive length.

FIG. 1.—SIMPLE CIRCULAR COMPUTING SCALE.

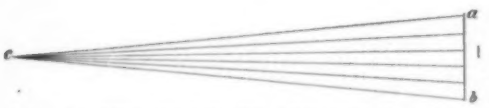


FIG. 2.—HOW DIVISIONS ARE SUBDIVIDED.

Continuity and compactness are both secured by the use of a circular instead of a rectilinear form; a single series of divisions then constitutes an endless scale, and a circle of about 13 inches diameter replaces the pair of 80-inch slides.

Fig. 1 shows the method of graduating the instrument, but owing to the reduced scale on which it is reproduced the divisions are not as small as possible. The relation between numbers and their logarithms, as represented by commensurate spaces, will be observed. The logarithms (outer circle) are equally spaced; the successive correlated numbers (inner concentric circle) are, reckoning clockwise, in a series of gradually reducing intervals, diminishing in a ratio which it is not necessary to consider here; it suffices to state that it is identical with that of the usual logarithmic tables.

It is a property of a logarithmic series that numbers (or lengths, measured always from an initial point or base line, 1 in the inner circle of the diagram) if *added* will give a number equivalent to the product of the numbers taken. Conversely, if *subtraction* be substituted for addition, the resultant number is equal to the quotient obtained by the division of the given numbers, one by the other. To assist in the calculations a pair of pointers are employed which are hinged together and are also pivoted to the center of the scale disk. As an example of the method of multiplying, place the inner edge of one of the pointers in coincidence with 1, or the fiducial mark on the circle of numbers, extend the other limb to, say, 2; bring the first edge to, say, 3; then the second edge will fall upon 6, as shown in the diagram. Thus a part of a logarithmic scale extending to 2 has been added to a part extending to 3, and the sum is a part extending to 6, equal to their product; that is, by a process of addition 2 has been multiplied by 3. Conversely, assume that with, say, the same setting (2), from 6 the part 2 is taken, then the indicator falls upon 3, and division of rotation, it virtually enters upon a second revolution or extension of the scale, and the value so found must in consequence be increased or decreased tenfold, according as to whether multiplication or division is in progress. For instance—still with the setting of 2—if the part 2 be added to the part 9, the indicator crosses the base 1 and marks 1.8 in a second revolution, hence the result must be read $1.8 \times 10 = 18$.

To raise a number to any power, either whole, decimal or mixed, or to extract the corresponding root, advantage is taken of another property of a logarithmic series, viz.: if a log. of a number be simply multiplied or divided by the numerical value of the given power or root, the result will be the logarithm of the respective power or root required.

To illustrate: Assume that the cube of 2 is required, then radially adjacent to 2 in the inner circles of numbers will be found .301 in the outer circle of logarithms; this is the logarithm of 2, hence if the logarithm .301 be multiplied by the number of the power given, in this case 3, the result will be the logarithm of the number sought. Adjacent to .903 in the circle of logarithms will be found 8 in the circle of numbers, therefore 8 is the value of 2 raised to the third power or cubed.

Conversely, to find the cube root of 2. Logarithm of $2 = .301$ as before, $.301 \div 3 = .100$ (nearly) or the logarithm of the number sought; adjacent to .100 the number is 126; allowing for the decimal point this is read 1.26, and is—within the limits of accuracy of the instrument—the result.

In making an instrument of this sort the primary essential is the logarithmic, or outer circle, decimally divided, preferably into 1,000 equal parts. In the absence of a lathe or gem cutting machine the graduations may be effected as follows: Step the circle into five equal parts and bisect each of these to obtain the ten primary divisions; do not trust wholly to the dividers, or to a preliminary bisection by a line drawn through the center, but check the result by transferring the points to a segment of thin card, and applying it to each division before final ruling. Divide the paper arc into ten secondary parts, first bisecting, then stepping by 5. Check these and when found correct, transfer to the ten segments of the circle. Similarly divide one of the secondary spaces into ten spaces, and carry the tertiary marking round the circle. The whole of the divisions in the circle of numbers may be set out by the use of the table of logarithms in conjunction with the graduations of the outer circle, but the method would be extremely tedious. The writer found that after a certain number of points have been determined by such comparison, a few simple devices serve to apply the rate of variation so obtained to the other segments, and to carry the work on quite expeditiously.

The logarithms of the primary points 1, 2, 3, 4, 5, 6, 7, 8, 9, are respectively .000, .301, .477, .602, .699, .778, .845, .903, .954.

If the figures in the second line be located in the outer circle, then the points on the same radius in the inner circle adjacent are the positions of the primary numbers, 1—9.

The places of the secondary, or decimal divisions, of segment 1 to 2 are similarly found by the following tables:

Number....	1.1,	1.2,	1.3,	1.4,	1.5,	1.6,	1.7,	1.8,	1.9,
Log.....	.041,	.079,	.114,	.146,	.176,	.204,	.230,	.255,	.278.

For closer reading each of these secondary segments is further divided into two—not bisected—by the use of the following:

Numbers...	1.05,	1.15,	1.25,	1.35,	1.45,	1.55,	1.65,	1.75,	1.85,	1.95.
Log.....	.021,	.061,	.097,	.130,	.161,	.190,	.217,	.243,	.267,	.290.

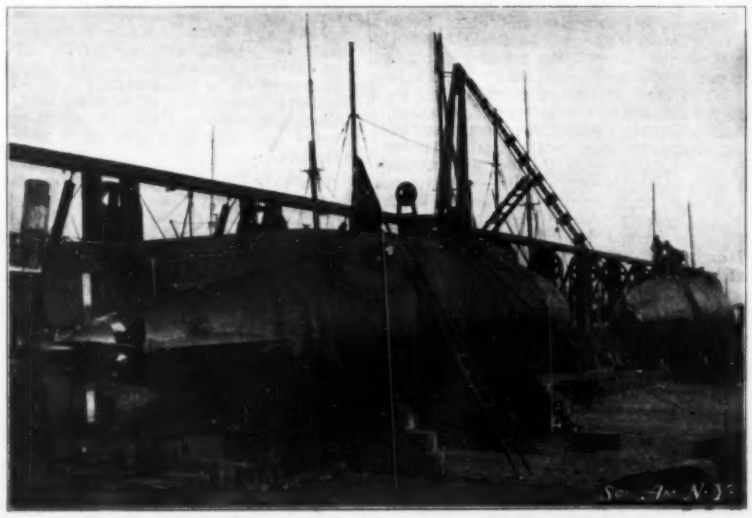
The divisions may now be carried fully round the circle and be subdivided into the smaller spaces by a form of diagonal scale, thus: Lay off on a piece of thin, hard paper, a line *ab* Fig. 2, slightly longer than the chord 1 to 1.1, or 1 to 1.05 if the division has been carried to twenty parts. Divide this line into five equal segments. To a point *c*, distant about 12 inches perpendicularly from the center of *ab*, draw from the end of each segment an accurately straight line. Snip across the lines until a straight section of the paper shows an overall measurement across the lines equal to the chord to be divided, then prick or dot off on the arc, continuing to cut back toward *c* as the divisions to be dealt with decrease in magnitude.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE SUBMARINE BOATS "PIKE" AND "GRAMPUS."*

THE "Grampus" and "Pike," two submarine boats of the Holland class, built at the Union Iron Works, San Francisco, Cal., have just passed all the tests to which they were subjected by the Navy Department.

On June 7, 1900, the government authorized the construction of six submarine boats, of which the craft recently finished at San Francisco formed a part. The "Grampus" and "Pike" are each 63 feet 4 inches in length, 11 feet 9 inches in diameter, and have a displacement, submerged, of 120 tons. When on the surface they are driven by a single-screw, four-cylinder, Otto gasoline engine of 160 horse power. They are provided with a generator of 70 horse power, which may either be driven by the gasoline engine for charging the batteries, or be thrown on to the batteries when the boat is submerged and used as a motor for driving the propeller. Like the rest of the class, the "Grampus" and "Pike" are built with a double bottom, and with three watertight compartments. In the forward compartment are the gasoline tank and the torpedo tubes. The amidship compartment contains the main ballast tanks, which are located in the double-bottom. Above them are the storage batteries, the torpedoes, and the air flasks, in which fresh air for the crew is stored at 2,000 pounds pressure. In the third compartment at the stern are the gasoline engine, motor, the clutches, and the steering gear.



THE "GRAMPUS" AND "PIKE" IN DRYDOCK.

Submersion is effected by trimming tanks assisted by a pair of horizontal driving rudders at the stern. The vessel is controlled from a conning tower protected with four inches of armor.

ELECTRIC SODIUM MANUFACTURE IN GERMANY.

H. DANNEEL gives some interesting information concerning the electric sodium industry in Germany. Four establishments are engaged in the manufacture. At Bitterfeld, the Elektrochemischen Werke use no less than 3,000 horse power in the process, but information concerning the output of the metal is not given. Another establishment, at Rheinfelden, uses 1,600 horse power, the resulting sodium being consumed in the

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

manufacture of cyanide and sodium superoxide. The Castner process is used in the larger establishments.—Zeitschrift für Electrochemie.

HERTZIAN WAVE TELEGRAPHY.

DR. FLEMING'S THIRD PAPER.

DR. FLEMING began his third lecture by explaining that in his previous lecture he had confined himself to transmitting arrangements and transmitters; in the present lecture the subject would be receiving arrangements and receivers. He threw on the screen the diagram which is shown in Fig. 35, of the first paper, and which illustrates Marconi's tuned aerial. The purpose of this, which is much like Fig. 2, was to make clear the operation of the signaling device, in which an induction coil, operating through a spark-gap and a condenser, sends an oscillating current through the primary of a transformer, the secondary of which is connected at one end to the aerial, and at the other end to the earth. Up to a distance of 150 miles, working with a coil capable of giving a 10-inch spark, such an arrangement works most satisfactorily. However, it was necessary in such case that the two circuits—the one connected with the coil and the other to the circuit of the aerial—should be tuned together, so that each would have the same electric time period. To communicate telegraphically, it was necessary to have two signals—the dot and the dash of the Morse code. These were usually sent by means of a hand-key, and the rate at which this key could be operated was one of the determining factors of the speed of transmission. Evidently it was impossible to receive the signals at a quicker rate than they were sent out; it had, therefore, been a matter of invention to produce a key with a very small amount of motion, so that the sending might be as rapid as possible. The lecturer had such a key on the table for exhibition.

Turning to the question of receivers, Dr. Fleming called attention to the model of electric waves which he had shown in his first lecture, and which is illustrated in Figs. 17 to 19 *ante*. He explained that the aerial threw off successive loops of electric strain, with horizontal rings of magnetic force, and that these rings continually spread, like the ripples in a pond into which a pebble had been thrown. The receiving aerial at the distant station was cut by the magnetic lines thrown off from the transmitting aerial, and it also absorbed the waves of electro-static force. In one sense the receiving aerial was like a wire in the armature of a dynamo. As the waves of magnetic force struck it and passed it, it cut them, and electromotive force was generated in it. Of course, in the dynamo the armature was moving and the field was stationary, whereas in this case the wire was stationary and the magnetic field was moving. The function of the rings of magnetic force which were thrown out from the transmitting aerial was to generate electromotive force in the receiving aerial, and for this purpose the receiver must have very considerable length. The electromotive force was the product of the length of the wire multiplied by the magnetic field, and nothing could make up for want of length in the aerial. There had been attempts in this direction, and Braun had suggested that a wire might be wound round and round a sheet of metal, as shown in Fig. 1; but this arrangement would not work, because while electromotive force was generated in each turn of the wire, a second electromotive force was also generated in the metal of the sheet around which it was coiled, and this latter electromotive force was antagonistic to the first, and nullified its effect.

Now, he had explained in previous lectures that the greatest electric pressure occurred at the top of the aerial, while at the bottom there was very little pressure, but a very considerable current, just as in the organ pipe (see Figs. 20 and 21 *ante*), there was an air pressure at the top of the pipe, and much motion of air opposite the mouthpiece. Now, in the early Marconi experiments at Bournemouth and Alum Bay an attempt had been made to connect the coherer by a wire to the top of the aerial; but this connecting wire was practically a second aerial, and the coherer was in no better position than if it had been joined to the base of the aerial itself. When multiple aerials were used (as in Figs. 22 and 23 *ante*) there was this advantage—that the currents in the whole of them could be added together at the bottom for the purpose of operating the coherer; but it must be remembered that it was the currents, and not the potentials, that were aggregated. There had been many inventions for the purpose of enabling the coherer to be put at the bottom of the aerial, and yet to obtain the benefit of the great pressure which existed at the top of the aerial. The method which had been adopted by Mr. Marconi was the use of a transformer (as shown in Fig. 2), which was called at Poldhu a "jigger," a jigger being, as he understood, a device for raising weights, and, by analogy, a device for raising pressure. The aerial was connected to the coil which formed the primary of a transformer, and as the maximum of current occurred at the bottom of the aerial, that was the position at which it was most advantageous to place such a coil. The effect of the current in this primary was to produce electromotive force in the secondary, which impressed itself upon the coherer and produced a current therein, just as if that coherer had been placed at the top of the aerial, where the greatest difference of potential existed.

Dr. Fleming said that the time had arrived to introduce a new word into the art of wireless telegraphy. The whole apparatus by which the messages were translated was called a receiver, which was too wide a word to be considered as a definition. The arrangement by which the electric impulses in the receiving aerial were utilized was called a "coherer;" but since that word had been introduced, contrivances for the purpose had been devised which did not cohere, and therefore the word was too limited in its application.

VARIETIES OF KUMASCOPES.

Contact.		—	
Non-restoring.	Self-restoring.	Magnetic.	Electrolytic.
Branly, Lodge, Marconi, and others.	Hughes, Nengschwender, Tommasina, Popoff, Castelli-Solari,.	Marconi.	De Forest.
		Electric.	Thermal.
		Schaefer.	Fessenden.

He had therefore ventured to coin a fresh word, which was "kumascope," derived from the Greek word κυμα, a wave; it was similar to electroscope, and many others of a like kind. Both our eyes and our ears might be defined as kumascopes, for they detected waves of light and waves in the air. Now there had been many forms of kumascopic devices, and he was not prepared

Fig. 1
Braun's Receiving Aerial.

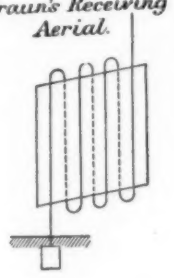
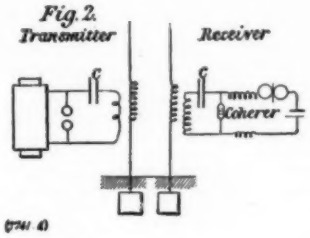
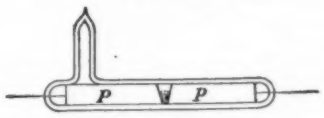


Fig. 2.
Transmitter Receiver



(7741)

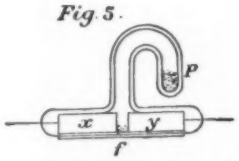
Fig. 3.
Marconi Sensitive Tube or Kumascope.



95 Parts Nickel Filings,
5 Parts Silver Filings
Beveled Silver Plugs P.P.

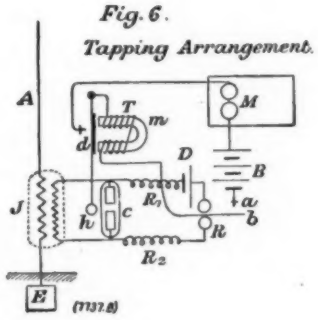
Fig. 4
Branly Tripod Coherer.

Fig. 5.



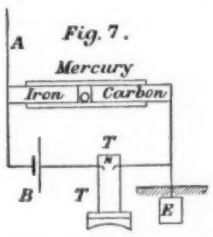
Blondel's Pocket Tube.

Fig. 6.
Tapping Arrangement.



(7737)

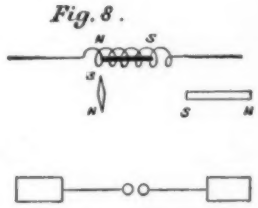
Fig. 7.



Italian Navy Receiver.

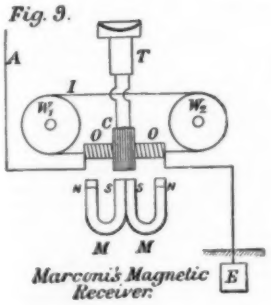
(7737.4)

Fig. 8.



Rutherford's Magnetic Hertzian Wave Detector.

Fig. 9.



Marconi's Magnetic Receiver.

Fig. 10
De Forest Electrolytic Kumascope

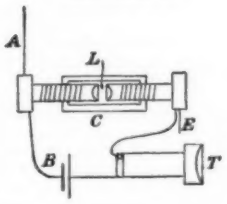


Fig. 11.
Fessenden's Thermal Receiver.

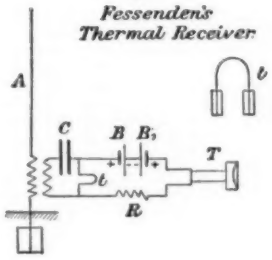
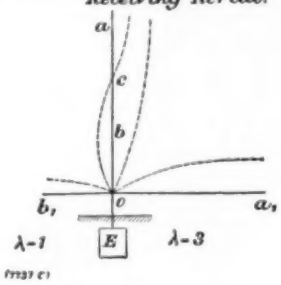
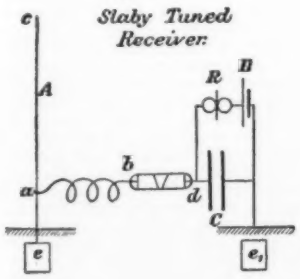


Fig. 12. Slaby Multiple Receiving Aerial.



(7737 C)

Fig. 13.
Slaby Tuned Receiver.



Braun's Syntonic System

Fig. 14.

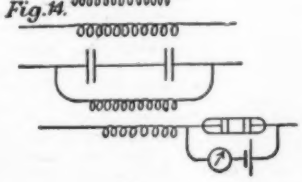
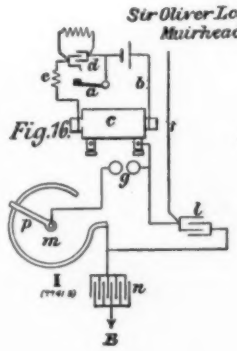


Fig. 15.
Lodge's Coherer

7741

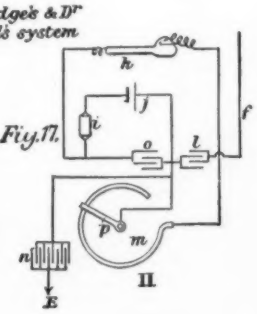
Sir Oliver Lodge's & Dr Muirhead's system

Fig. 16.



(7741 B)

Fig. 17.



to attempt to assign to each inventor his proper share of credit, nor even to treat the matter historically, but he would rapidly go over the principal devices which had been put forward for the purpose, as shown in the table in the previous page. It was very seldom that an invention burst full blown upon the world; generally it grew by a process of evolution, just as the twilight appeared before the dawn. It had often been recognized that there were curious inexplicable effects in connection with electric apparatus which our later knowledge had enabled us to attribute to electric waves. Dr. Fleming thought that in all probability the jerks exhibited by Galvani's frogs were rather the result of electrical waves than of galvanic excitation, for we were told at the time the phenomena took place a friction machine near by was giving sparks. Edison had chronicled some curious observations in regard to what he named "etheric force," which at the time he was not able to explain. Then, in 1879, Prof. Hughes found that the combination of a microphone and telephone gave audible sounds every time that an electric spark was produced, even at considerable distances. Unfortunately, he was not sufficiently confident with regard to his invention to hold his opinion against all comers, and he allowed himself to be persuaded that the result was the effect of induction, although he was able to produce the effect in Portland Place at a distance of several hundreds of feet from the spot where the sparks were being generated.

After the discoveries of Hertz, fresh light was thrown upon the subject, and many phenomena which were familiar to telegraphic engineers became explicable. Varley, as far back as 1855, had shown that granular substances would cohere during thunderstorms, and he had invented lightning protectors based on that property.

In 1884 Onesti had found that a tube of filings, which was ordinarily non-conductive, became conductive under the influence of an electric spark; but the matter had no interest at the time, and the record of it had been buried in an Italian journal.

In 1892 Branly described before the British Association the operation of his coherer, and it was noticeable that at that time Prof. George Forbes had suggested that the effect might be due to electric waves. In the year following it was recognized that Hertzian waves were capable of producing the effect.

Turning now to the modern examples of coherers or kumascopes, Fig. 3 shows Marconi's sensitive tube, containing 95 per cent of nickel filings and 5 per cent of silver filings. These fragments were contained in a wedge-shaped space between two silver cylinders, *p, p;* the purpose of making this space wedge-shaped was to vary the aggregation of the particles. When the tube was turned one way, the particles, which were so few as only to cover the head of a pin, filled the narrow end of the wedge; and when the tube was turned the other way, they filled the broad end of the wedge. To show the action of this tube, Dr. Fleming put it in the lantern and connected up to it a galvanometer, the light spot of which moved over the screen. The tube and galvanometer were connected up with a one-cell battery, and it was shown that the spark caused by the breaking of an electric circuit which had in it an electromotive force of only one volt was sufficient to cause the filings in the tube to cohere and the spot of light to move over the screen. The spark which produced this effect was too small to be seen even in the dark. Fig. 4 shows a Branly tripod coherer, in which a table with three pointed legs standing upon a disk of silver acts as a coherer. When an electric spark passes, one or more of these legs make electric contact with the disk, and the current passes through them. Blondel's adjustable coherer is shown in Fig. 5. This has a pocket, *P*, containing filings, which may be shaken down between the two cylinders, *x* and *y*, in the tube, *t*, so as to vary the resistance between the two. It has not been found, however, that this gives a better effect than Fig. 3. In the sewing-needle coherer, devised by Sir Oliver Lodge, two needles are in contact with an aluminium plate, and when a spark is produced the current will flow through them. The fault, however, with all these coherers which depend upon the contact of a fine point is that the contacts are apt to be blunted or burnt if too large a current passes, and thereby they lose their sensibility.

Dr. Fleming then went on to explain that the sensibility of a coherer was restored by tapping it, the arrangement used by Marconi being shown in Fig. 6. The coherer is so sensitive that if it passes a current of more than one-tenth of a milliampere, it is apt to be deteriorated. In Fig. 6 *A* is the aerial, and contains a coil which operates the secondary circuit in which is placed the coherer, *C*, two self-inductances, R_1 and R_2, a battery, *D*, and a relay, *R*. When a current passes down the aerial, *A*, it renders the coherer, *C*, active, and then a current flows from the battery, *D*, through the relay, *R*, and this brings into operation the secondary circuit containing battery, *B*, the Morse instrument, *M*, and the tapper, *T*. As long as the current flows through this latter circuit, the armature *d* of the electro-magnet, *M*, is kept in vibration, and the hammer, *h*, taps the coherer, *C*, and consequently restores it to an active condition. The lecturer had on the table an actual example of Marconi's apparatus, in which there are many fine adjustments, in order that the tapping might be of the required frequency and strength. There were, the lecturer proceeded to explain, many other tapping arrangements besides the one shown in Fig. 6. According to one plan the coherer was fixed to the armature of the magnet. In some coherers the particles themselves were magnetic, and an electro-magnet caused the chains of particles which were created by the cohesion to be torn apart. According to another plan a wire coil was wound around the coherer, and was traversed by an alternate current, which effected the decoherence.

For a period all the coherers were of the type already set forth, but, later, telephonic coherers came into use, and as these were self-restoring, they did not need to be tapped; they were the descendants of Hughes's microphone, which spontaneously separated. The earliest type of these is shown in Fig. 7. It represents the Italian navy receiver. In this two cylinders —one of iron and the other of carbon—are connected by a globule of mercury, and the circuit from the aerial, *A*, is completed through this globule, through the primary cell, *B*, and the telephone, *T*. When electric waves descend from the aerial, they have the property of making the mercury globule adhere to the iron and to the carbon, and of making good contact between the two. Thus, when the aerial receives the impulses, it causes the circuit to be completed between the iron and the carbon, and the battery, *B*, sends a current through them and through the telephone, the latter giving a click which can be heard and understood as a signal. Another form of receiver had been invented by Neugschwender. In this a film of silver was laid upon a glass plate, and was cut through by a razor. When such a plate was breathed upon, it became conductive under the influence of electric waves; while when there were no waves, it was practically a non-conductor. Schäfer had also devised an example of the same kind, in which a silver film was torn through by a razor. There had been many theories set forth to explain its action, and it appeared as if the fragments of silver left from the cut arranged themselves under the influence of the electric oscillations across the cut, and made a connection from one side to the other.

The first form of magnetic Hertzian wave detector was due to Rutherford, who, at Cambridge, had been able to detect electric waves at the distance of several hundreds of feet. The arrangement is shown in Fig. 8, in which *N S* represents a small piece of magnetized iron surrounded by a coil. Close to this is a magnetic needle and a small permanent magnet. When a spark occurs at a distance, the electric waves are received by the wire, of which the coil is a portion, and passing through the coil, demagnetize the iron within it, which is in a very unstable condition. The result of the change is shown on the magnetic needle, which moves its position. This, however, cannot be called a telegraphic signal, because there is only one motion, and it does not contain the elements of the dot-and-dash, which are necessary for the expression of an alphabet.

Fig. 9 showed, the lecturer said, Mr. Marconi's beautiful magnetic receiver, which depended for its action on the demagnetization of iron by electric oscillations. In this the iron band, *I*, was kept constantly moving round the pulleys, W_1 and W_2, and passing through the coil, *O O*. This coil was connected at one end to the aerial, *A*, and at the other end to earth. The portion of the band in the coil, *O O*, was magnetized by the two magnets, *M M*, and in consequence of the magnetic inertia, a portion of the band outside the coil, *O O*, in the direction in which the band was traveling, was also magnetized, but was in a very unstable condition. Now if electric oscillations came down from the aerial, and through the coil, *O O*, they had the effect of demagnetizing the band, *I*, and the magnetism in the portion which protruded from the coil disappeared, slipping back into the coil as a rabbit slips back into its hole at the approach of danger. The portion within the coil was, of course, subject to the induction of the magnets, *M M*, but the external portion was demagnetized by the oscillations from the aerial, *A*. Around the coil, *O O*, was a second coil, *C*, connected to a telephone, *T*, and when the magnetism of the band, *I*, was disturbed or destroyed by the oscillations, a sound was heard in the telephone which was either short or long—that is, a dot or dash, according as the oscillations in the aerial, *A*, persisted for a longer or a shorter time. It was with an apparatus of this kind that messages had been transmitted across the Atlantic.

Dr. Fleming said that there was no apparatus for the detection of electric waves which was so sensitive as the telephone and the human ear, and it was not likely that there would be. He, however, had endeavored to devise an apparatus in place of this telephonic one (Fig. 9), which should give a visible signal. After trying various forms, he had found that a convenient magnetic detector for Hertzian waves could be constructed in the following manner:

On a pasteboard tube are placed six bobbins of hard fiber, each of which contains about 6,000 turns of No. 40 silk-covered copper wire. These bobbins are joined in series, and form a well-insulated secondary coil. In the interior of this tube are placed seven or eight small bundles of iron wire, each about 6 inches in length. Each little bundle of iron is wound over uniformly with a magnetizing coil formed of No. 36 silk-covered copper wire in one layer; and over this, but separated from it by one or two layers of gutta-percha tissue, is wound a single layer of No. 26 wire, forming a demagnetizing coil. The magnetizing, or inner, coils are connected in series with one another, so that when a current passes through the whole of them, it magnetizes the whole of the wires in such a manner that contiguous ends have the same polarity. The outer or demagnetizing coils are joined in parallel. Associated with this induction coil is a quadruple rotating commutator, rotated by an electric motor about 500 times a minute. Four little springy brass brushes make contact with the circumference of the four wheels, and therefore serve to interrupt or make electric circuits as the disk revolves. The function of the disk No. 1 is to make and break the circuit of the magnetizing coils placed round the iron bundles, and thus to magnetize them during a portion of one period of rotation of the disk, and leave them magnetized during the remaining portion. The function of disks 2 and 3 is to short-circuit the terminals of the secondary coil of the bobbin during the time that the magnetizing current is being applied by disk No. 1. A sensitive movable coil galvanometer is employed in connection with the secondary coil, one terminal of the galvanometer being permanently connected to one terminal of the secondary coil, and the other terminal connected through the intermittent contact made by the disk No. 4. This disk No. 4 is so set that during the time that the secondary coil is short-circuited, and while the battery current is being applied to magnetize the iron wire bundles, the galvanometer circuit is interrupted by the contact on disk No. 4.

The operations which go on during one complete revolution of the disks are as follows: First, the magnetizing current of a battery of secondary cells is applied to magnetize the iron bundles, and during the time the terminals of the fine wire secondary coil are short-circuited, and the galvanometer is disconnected. Shortly after the magnetizing current is interrupted, the secondary bobbin is unshort-circuited, and an instant afterward the galvanometer circuit is completed, and remains completed during the remainder of one revolution. Hence, during a large part of one revolution the iron wire bundles are left magnetized, the magnetizing current is stopped, and the galvanometer is connected to the secondary coil. If during this period an electrical oscillation is passed through the demagnetizing coils, an electromotive force is induced in the secondary bobbin by the demagnetization of the iron, and causes a deflection of the galvanometer coil. Since the interruptor disks are rotating very rapidly, if the electrical oscillation continues, these intermittent electromotive impulses produce the effect of a continuous current in the galvanometer circuit, resulting in a steady deflection, which is proportional to the demagnetizing force being applied to the iron, other things remaining equal. If the oscillation lasts only a very short time, the galvanometer will make a small deflection; but if the oscillation lasts for a longer time, then the galvanometer deflection is larger, and tends to become steady.

By means of such an arrangement it is possible to verify the law according to which variation falls off with distance, and to compare together the wave-making power of different radiators. This detector serves, for instance, to show in a very marked manner the great effect of slight differences in the surfaces of the spark-balls. If a steady series of sparks from an induction coil is passed between the spark-balls of a Hertz linear radiator, it will produce a steady deflection on a galvanometer connected with the above-described receiver placed at a distance. If the balls are then polished, the galvanometer deflection immediately increases considerably. If, on the other hand, the balls are slightly smeared with oil, the galvanometer deflection decreases. If the radiator is approached to the receiver, or withdrawn from it, corresponding variations in the galvanometer deflection take place.

In America, the lecturer said, several forms of kumascope had been worked out. That of De Forest (Fig. 10) depended upon electrolytic phenomena in a small cell, *C*, where two screws with recessed ends, filled up with a paste of peroxide of lead, inclosed a space, *L*, filled with a mixture of glycerine and water and some metallic salts. The whole was in circuit with a battery, *B*, and a telephone, *T*, and was connected to an aerial, *A*. The effect of the current was to build up electrolytic chains of particles across the space, *L*, between the screws; but when an oscillating current came down the aerial, *A*, these chains were torn down, with the result that a click was heard in the telephone, *T*. Another very delicate form of kumascope was Fessenden's thermal receiver, shown in Fig. 11. This depended for its action upon a very fine platinum wire, *t*. This wire was produced by an old device, of casting a silver cylinder around a platinum thread, and then drawing the whole down as fine as possible. Afterward the silver was removed by nitric acid and left the core of platinum, which was of too small a diameter to be seen except by a microscope. This wire, *t*, was mounted as a bridge, short-circuiting the secondary circuit shown in Fig. 11. In this circuit were a condenser, *C*, and two cells, *B, B*, set to oppose each other, the resulting electromotive force being the difference, and not the sum, of the electromotive forces in the two cells. This small electromotive force sent a current through the platinum wire, *t*, the inductance, *R*, and the telephone, *T*. When electric oscillations came down the aerial, *A*, they produced a current through the condenser, *C*, and the platinum wire, and the effect of this current was to heat the wire and increase its resistance. This increase of resistance reduced the current through the telephone, *T*, and produced in it a click which might be recognized as a Morse signal. Of course, such a kumascope as this required no tapping.

Dr. Fleming then returned to the question of connecting the coherer to the aerial in such a way as to obtain a large difference of electromotive force in it, and showed, in Figs. 12 and 13, how Slaby had accomplished this result. In Fig. 12 is shown the differences of pressure in the aerial, according as it is arranged to give its fundamental tone or its first harmonic. Now if a wire be stretched horizontally from the base *o*, of such an aerial, toward a_1, there will be a similar arrangement of pressure in the horizontal arm as in the vertical, and consequently at the end of the wire, a_1, the conditions are the same as those at *a* on the vertical wire. Further, it is not necessary that the wire, $o\,a_1$, should be perfectly straight; it may be wound up into loose spirals, as shown in Fig. 13, and the coherer, *b d*, may then be connected to it, with exactly the same effect as if it were connected to the top of the aerial. In this figure *R* is the relay, *B* the battery, and *C* the condenser.

To avoid the inconvenience of having to erect a vertical aerial the lecturer explained that Braun had tried the syntonic system shown in Fig. 14, in which the transmitting and receiving wires had been stretched horizontally, as shown. The lecturer, however, did not think that the horizontal wire could ever compare in effect with the vertical one; and, further, he was of opinion that to obtain the best result it was necessary that the vertical aerial should be earthed. The two vertical wires and the ground, or the sea between them, formed part of one circuit, of which the earth was an integral portion, and could not be omitted without loss.

Dr. Fleming concluded his remarks by a description of Sir Oliver Lodge's coherer. In this, he said, a rotating steel disk (Fig. 15) was in contact with a convex surface of mercury protruding from a vertical tube. Ordinarily there was no electrical connection between the mercury and the steel—the fluid did not wet the solid; but when electric oscillating waves were passing, they had the property of making a connection between the two, so that a circuit was completed from the steel disk to the mercury; when the waves ceased, the connection ceased, and so the arrangement was self-decohering. Figs. 16 and 17 showed the general arrangement of the system employed by Sir Oliver

Lodge. In these figures the left-hand diagram shows the sending station, and the right-hand diagram the receiving station. At the sending station the aerial, *f*, is connected to a condenser, *l*. The opposite terminal of this condenser is connected to earth through the condenser, *n*, and also to the spark-gap, *g*, through the adjustable inductance, *m p*. The electric energy is derived from the coil, *c*, which has a trembling break, and this coil can be put in and out of circuit by the key, *a*. This key short-circuits the condenser, *d*, and the inductance, *e*. On the other diagram the aerial ends in a condenser, *l*, and the oscillations set up in the aerial by the Hertzian waves excite other oscillations in the circuit of the condenser. This condenser, *l*, has an overflow path in which the coherer, *h*, is inserted for the purpose of detecting the overflow with the battery, *j*, the telegraphic receiver, *i*, and a subsidiary condenser, *o*. The object of the subsidiary condenser, *o*, is to act as a shunt to the battery and receiver as far as sudden electric changes are concerned, and this affords an easy path for overflow from the main condenser, *l*. In order to provide for efficient tuning or syntonism between the sending and receiving circuits, the length, or self-induction, of each condenser circuit is capable of adjustment by a sliding contact, as at *p m*.

INVESTIGATIONS IN PHONOGRAPH PHENOMENA.

PROF. M'KENDRICK, of the Glasgow University, has been carrying out prolonged investigations relative to the phonograph and the attendant phenomena concerning the repetition of articulations as accomplished by the phonograph. As is well known, the principle of the phonograph is the recording of each and every vibration of a sound on a wax cylinder in the bottom of a spiral groove, by means of a finely adjusted sensitive needle. These sounds can afterward be repeated by running over the marks so recorded. These marks upon the wax cylinder constitute a series of wax forms, some of which are of great complexity. Prof. M'Kendrick has devised an instrument by means of which the wave marks on the phonograph cylinder can be transcribed in a greatly amplified form on a strip of paper similar to that used in a printing telegraph. Six inches of the strip of paper shows the waves that are imprinted on the wax cylinder of the phonograph in 1-6 of an inch, representing the 1-100 of a second.

All sounds, whether they be breathed (whispered) vocal sounds as in singing, or articulate speech, have a distinctive physical nature, since they all differ in intensity, pitch, and quality. Prof. M'Kendrick has devised a method whereby the intensity or loudness of tones from the phonograph may be augmented. The sound waves fall on a microphone, and the electrical variations so produced pass through the primary coil of an induction machine. Corresponding variations, but more intense, occur in the secondary coil, and the current so produced acts on a specially constructed telephone. When the currents so modified by the microphone are applied to an electro-magnet acting on a membraneous drumhead partly covered by a ferrotype plate, each variation in the magnetic field produced by the sound of a note coming from the phonograph can be recorded on the blackened surface of a rotating cylinder.

Furthermore, he has devised a means for directly registering the vibrations of all tones of speech, so that they may be seen. A rigid lever is attached to the recorder of the phonograph. This is brought against the surface of a smoked glass plate, which, by a mechanical contrivance, dashes across the point of the stationary lever with great velocity, while a sound is articulated to the disk of the phonograph. It is thus demonstrated that for a given pitch each vowel has its own wave form. When an explosive consonant like *p* comes before the vowel, no marks on the glass plate are made for *p*, but there are the wave forms for *o* when *o* is sounded after *p*, as in *po*. It is a curious fact that a consonant always modifies the wave form of the vowel following it or coming before it, as in *po* or *op*. Through his investigations Prof. M'Kendrick has discovered that the consonant *r* is made up of little groups of vibrations, consisting of nine vibrations, and then a break with no vibrations, and so on so long as *r* is sounded. The nature of many speech sounds may also be easily and readily determined. In the pronunciation of *i* as *ee*, the tone of the larynx may have a pitch varying from 400 to 500 vibrations per second, but it is associated with a harmonic tone, the vibrations of which are as high as 3,000 per second and yet are easily distinguishable.

The investigations of Prof. M'Kendrick in the ramification of phonetics show that: 1. Vowels are musical tones produced in the larynx, but they owe their special quality to the fact that the laryngeal tone arouses by resonance mouth tones, which are added to the laryngeal tone or they may mask it to such an extent that it may scarcely be heard. The pitch of these mouth tones need not be necessarily simple multiples of the pitch of the laryngeal tones, but they are often of this character. The pitch of the mouth tones is variable, owing to the possibility of infinitely small changes in the capacity of the oral, nasal, and other cavities of the face, depending on the individual, and thus we may say that there are hundreds of vowel sounds. But while this is so, the variation is never beyond a certain limit, so that the vowel *a* (pronounced *ah*) for example, is always recognizable as *a*, whatever may be the pitch of the note on which it is sung. Thus, just as no two human faces are absolutely alike, so no two vowel tones produced by different persons are identical in quality. If such were not the case, we should be unable to distinguish one human voice from another.

2. Consonants are breaks or stops in the current of air, or when they are continuants they modify the current of air as it passes through the oral cavity. Some are voiced, as *v* (in *vowel*), others are voiceless, as *f* (in *father*). When voiced, the tone is partly produced in the larynx; when voiceless, there is no sound. A consonant like *p* gives no sound until the lips are opened and a vowel is sounded, but the form of the vowel curve, whatever may be the vowel, is altered by the nature of the explosive opening, or by the suddenness of closure, as in *m* and *n*. Thus the curve of *p* is different from that of *b*. The instant the lips are opened, as in *p*, there is a sudden pressure on the ear, not a series of vibrations, and this is followed first by modified waves (representing pressures) and then by the special vibrations or pressures of the vowel. With *b* there is much less pressure on the ear, and there are two or three vibrations, as *b* is not a silent consonant, and these are followed by the modified vowel pressures, and then by the true vowel pressures corresponding to the vowel. The modified vowel is produced during the short time in which the oral mechanism is adapting itself to the vowel, as in *po* or in passing from the vowel to the closure, as in *op*. Thus the ear, because it is so wonderfully sensitive, infinitely more sensitive than any phonograph or telephone, catches the little variations, and we can distinguish between *p* and *b*, although both form at the lips. And the same individual distinctness is noticeable in connection with all the other consonants.

IN THE HEART OF THIBET.

IN the summer of 1900 M. Zoubikoff entered Thibet from the north as a member of a caravan of seventy pilgrims, including many Lamas. He approached Central Thibet by the Boumza Mountains, where Przhevalsky was turned back in 1879. The road led through a treeless alpen landscape, with snow-topped mountains extending east to west in parallel chains, and a thin, nomadic population. An agricultural community was found only within sixty or seventy miles of Lhassa.

The climate was found to be harsh and dry. Snow falls occasionally from December to March; rain from May to August; April, September, October and November are dry. The medium annual temperature was found to be 42, 67, and 50 degrees Fahrenheit for morning, noon and night, respectively. The data for December are 17, 34, and 27 degrees, and for July, 60, 77, and 65 degrees.

The population, which has at times been estimated at 33,000,000, is probably about one-tenth this number. It is decreasing through disease, particularly smallpox, and on account of the large number of celibate priests.

The sons of Chinese soldiers and merchants temporarily resident in Thibet are counted Chinese, the daughters Thibetans. Other foreign residents are Indians from Cashmere, Mongolians and Thibetans from Neual, the latter being skilled artisans, architects, sculptors and jewelers. The Cashmere Mohammedans are traders. They usually convert their Thibetan wives.

Almost all the land in Central Thibet belongs to the Dalai Lama. Only high officials in Lhassa have hereditary homes. The Thibetan houses are of brick and stone, but have chimneys only in the kitchen. The other rooms have holes to let the smoke escape, and are cheerlessly cold. Dried dung is the principal fuel.

The common run of folks wear white, the wealthy red, officials yellow, and soldiers blue clothing of homespun. Jewels are worn in great abundance by the women. Barley meal, soup, the raw flesh of the yak and of sheep, butter, sour milk, and vegetables are the main items of the diet. Wheat spirits sell for a cent a bottle. Men smoke tobacco and the priests take snuff.

The people of Central Thibet are passionately attached to their religious observances, which are purely formal. Prayers are regarded as of magic potency and figure in all ordinary and extraordinary affairs of life. Medicine is in small popular favor. Morals are primitive and marriage ties are loose. Both polygamy and polyandry are common.

Agriculture and cattle raising are the principal employments. Wheat, barley, peas and beans, cattle, sheep, yaks, horses, asses, and mules are the main products. Yaks and asses are used as pack animals. Labor is cheap, men being paid two or three cents a day, while women usually serve for their keep. Even a Lama receives only ten cents for a whole day's prayers. Sheepskins, cattle, yak tails, statues, books, and yellow lama caps are exported. The yak tails serve as horse tails in the outfit of Turkish pashas. English and Indian cottons and woolens and copper and enamel utensils are introduced from India; tea, silks, and cottons, horses and asses from China.

Lhassa was built in the seventh century. It has a picturesque location on the southern slope of a mountain, with luxurious gardens on the west and south. The Uitchu River passes to the south of the city. Dikes and canals have been constructed as a protection against overflows. A fine broad street around the city serves for religious processions and penitential exercises.

Penitents go the length of this street, falling to the ground every five or six feet, so that in a day they prostrate themselves about three thousand times. The city is small, having at most only 10,000 regular inhabitants. It is, however, an important trade center. The native traders are all women.

The temple of Buddha, in the center of the city, is about 140 feet square. It is three stories high, and has three gilded Chinese roofs. It shelters the gigantic bronze statue of Buddha, which has a hammered gold jeweled headdress. A sacrificial fire fed with melted butter burns before the statue. Other statues and relics are kept in other chambers of the same temple, among which is the statue of the Goddess of Women, to which are offered spirits and wheat. The wheat is at once eaten by mice. In the same temple are also rooms for the Dalai Lama and his council.

The residence of the Dalai Lama is about a mile away from Lhassa, on Mount Bodala (Buddha La). It was built in the seventh century. Near by is the old castle Hodson-Bodala, which is 1,400 feet long and nine stories high. Here are located the treasury, the mint, the schools of theology and medicine, quarters for 1,200 officials and 500 monks, and a prison. As many as 1,000 priests participate in religious processions to this mountain.

M. Zoubikoff also minutely described various monasteries and temples, including three near Lhassa, where 15,000 monks are mainly engaged in learned pursuits. At one of these, Brabun, nearly 6,000 boys, young men, and even gray-bearded patriarchs are studying theology, the total number of resident monks being 8,000.

Thibetan Buddhism, brought from India in the seventh century, struggled against the native Shamanism until the ninth century, when a compromise was agreed upon. According to the current teaching, there are many spirits which are continually reincarnated in men.

The Dalai Lama is the living Buddha. Another Defender of the Faith is the Spirit Choidshen, whose power is manifested through pious ascetics that spend their lives in contemplation.

Since the fifteenth century, all power, civil and spiritual, has been nominally in the hands of the Dalai Lama, but China maintains a Manchu Resident and an army. In order to avoid strife in selecting a Dalai Lama, the Electoral Council places three strips of paper with the names of three boys in an urn, and the Manchu Resident removes one with a small staff. The new Dalai Lama's education is intrusted to a college of learned men. Until his twenty-second year the government is in the hands of a Regent appointed by the Emperor of China.

The present Dalai Lama is twenty-seven years old. He is the fifth since 1806, one of the Regents having continued in authority for an unusually long time owing to three children selected to be Lamas having died before attaining maturity.

The Dalai Lama's Council, in whose hands the actual power mainly resides, embraces four so-called "Galons," appointed by the Emperor of China. The administration is in the hands of a closed aristocracy, and bribery and corruption are nearly universal.

Among the common penalties are drowning, torture, flogging, banishment, and fines. The Thibetan army, of 4,000 men, is poorly disciplined and is armed with bows and old-fashioned guns. Robbery flourishes.—New York Times.

THE ORIGIN OF THE DIAMOND.

By E. M. SOUVIELLE.

THE diamond has recently attained a scientific importance which justifies any effort to solve the mystery of its origin.

In 1898, before the American Association for the Advancement of Science at Boston, in advancing the theory of their meteoric formation, I offered the first explanation ever suggested. The facts were then sufficient to sustain it, and the recent discovery of the most perfect diamond ever found in a known meteorite has demonstrated what I then maintained, that diamonds are visitors and not natives of the earth.

It is now positive that in interplanetary space are bodies and conditions where diamonds are manufactured, of a more perfect formation than any found on the earth.

The only question possible to raise against my theory is, Are all diamonds of meteoric origin?

As the evidence now stands, it is all in favor of their celestial origin, and no fact is found to give testimony to the other side.

The volcanic theory is untenable for many reasons, and it is the only alternative to offer.

Diamonds cannot be formed in the presence of oxygen, and the necessary conditions of heat, pressure and electrical energy, while they are all possible in volcanic action, were never succeeded by sudden cold, which is equally requisite to the formation of the diamond crystal, as proved by Moissan in Paris and Kronchoff in Russia.

The reasons that they are not of terrestrial origin, and must have been formed under conditions never possible in the earth are these:

1. Oxygen is everywhere present.

2. Sudden cold never succeeded intense heat, as terrestrial temperature changes are slow in operation.

3. They cannot possibly be reconciled with any of the eras of geology, and have been denied a place by all geologists.

4. They are always isolated, and are never found in masses of carbon, so common in all parts of the earth.

5. They are consequently never found in a matrix when they could have been manufactured, as is the case with all other crystals.

6. They have different refractive powers in their interior and exterior layers, owing to tension during their formation, according to Sir David Brewster, and others later.

7. As conclusive, they have a different law of crystallization from carbon of known terrestrial character and formation. This fact as certainly proves them of meteoric origin, as the meteoric forms of iron and other minerals tell of their celestial birth.

8. The diamonds of Kimberly are liable to crack or fly to pieces on coming into the air, and the diamonds of the meteorite in Arizona have done the same. This establishes a most remarkable relationship and proves them all to have been subject to a pressure unknown to any terrestrial era which they have experienced.

9. A perfect diamond was never found except in a meteorite. They are all fragmentary, broken, fissured, corroded and coated with foreign material, differing in individual cases and localities.

Several writers have maintained against my theory, that the diamonds of Kimberly were certainly not of meteoric origin, even if it were true of all others.

In his book on "The Diamond" now before me, Prof. Henry Carvil Lewis says, in reference to the kimberlite, as the diamond-bearing rock of South Africa is named:

"Olivine in round fragments constitutes the largest part of the formation, and this is also a common feature of meteorites. The rock differs from any other earthly formation The structure can only be compared with meteorites. Dr. Wadsworth says these rocks possess the structure of meteorites."

The diamonds from Kimberly are found to have optical anomalies due to strain. Fizeau thought this to be due to unequal distribution of heat during rapid cooling. This seems to be proven by the fact stated above that diamonds frequently crack or explode on being taken from the mine, exactly as do those found in meteorites. The only conclusion from this is, that all of them have been formed under the same or similar

conditions, and these are known to be true of meteorites, but impossible in the earth at any stage of its history.

It seems that all diamonds have exploded at some time in their existence, as that alone can account for their fragmentary character.

Many other scientists have noted the resemblance of kimberlite to meteorites and go so far as to say that it is like to no rock of terrestrial origin.

From this point it is not far to my theory that they are all of celestial birth, yet it must be true of all diamonds if it be true of any.

One argument raised to answer me was, that the great mass of kimberlite was proof that it could not be meteoric. In reply to this, the meteorite mountain of Arizona is sufficient refutation.

Even when all this is accepted, the story of the diamond is only half told, and my explanation of its life-history is also half in reserve. This much is demonstrated, the diamond is of celestial origin. It is of late date on the earth, later than any geological era, and that the great deposits of the southern hemisphere came from the same direction at the same time, as they are found on all the continents and islands of that region, in similar superficial positions in drift and river beds.

The possible diamond mines of the future may be found in the great continents of the South Pole, as they are near the center of the great circle of diamond-bearing countries.

The ancients believed the gem to be a celestial visitor, but upon what evidence does not appear to be a matter of record, so far as known. It is of interest that modern research has proved them to be correct.

The present expedition of scientists to Cañon Diablo mountain to ascertain its character is owing to the finding of the perfect diamond near there in a meteorite. The mass has long been known to be meteoric and also to contain numberless minute black diamonds. News from them will be awaited with interest.

SELECTED FORMULÆ.

Sympathetic Inks.—The following inks are developed by exposure to the action of reagents:

1. Upon writing with a very clear solution of starch on paper that contains but little sizing, and submitting the dry characters to the vapor of iodine (or passing over them a weak solution of potassium iodide) the writing becomes blue, and disappears under the action of a solution of hyposulphite of soda (1-1,000).

2. Characters written with a weak solution of the soluble chloride of platinum or iridium become black when the paper is submitted to mercurial vapor. This ink may be used for marking linen, as it is said to be indelible.

3. Sulphate of copper in very dilute solution will produce an invisible writing, which will turn light blue by vapors of ammonia.

4. Soluble compounds of antimony will become red by hydrogen sulphide vapor.

5. Soluble compounds of arsenic and of peroxide of tin will become yellow by the same vapor.

6. An acid solution of iron chloride is diluted until the writing is invisible when dry. This writing has the remarkable property of becoming red by sulphocyanide vapors (arising from the action of sulphuric acid on potassium sulphocyanide in a long-necked flask), and it disappears by ammonia, and may alternately be made to appear and disappear by these two vapors.

7. Write with a solution of paraffin in benzol. When the solvent has evaporated, the paraffin is invisible, but becomes visible on being dusted with lampblack or powdered graphite, or smoking over a candle flame.—Pharm. Era.

Lubricants for Glass Stop Cocks.—(Volumetric). Some years ago the following formula was recommended by an English chemist who stated that the resulting mixture lubricates well, is translucent, adheres to the glass, and is not saponifiable:

Pure rubber	14 parts
Spermaceti	5 parts
Petrolatum	1 part

The materials are thoroughly mixed while hot, the rubber being melted first and the other ingredients stirred in. A little more soft paraffin should be used in winter than in summer.

Pure rubber	7 parts
Yellow wax	3 parts

The rubber is heated in a covered vessel until thoroughly melted, the wax added, and the hot mixture well stirred. This lubricant is quite translucent in thin layers, and protects stop cocks from sticking even when used for concentrated solutions of caustic alkalies.

To keep the rubber mixtures in the best possible condition, they should not be exposed to air longer than necessary when heating, and they ought to be preserved in closed bottles. The stop cocks should occasionally be thoroughly cleaned and recoated with the rubber mixture.—Pharm. Era.

Deep-Black Writing Fluid.—

Logwood extract (best French)	200 parts
Potassium dichromate	2 parts
Chrome alum	50 parts
Oxalic acid	10 parts
Carbolic acid	10 parts
Water	sufficient

Dissolve the extract in 1,000 parts of water, by the aid of heat, in the water bath, and set the solution aside for eight days to settle. At the end of this time pour off the clear liquid, and heat 200 parts in the water bath to about 90 deg. C. (196 deg. F.), thinning it before heating with 500 parts of water. Dissolve in 150 parts of water the dichromate, alum and oxalic acid, and add it to the hot liquid. Continue the heat for a half hour, keeping it as nearly as possible at 90 deg. C., then add water sufficient to make 1,000 parts. Add the carbolic acid and again set aside for a couple of days to settle. At the expiration of this time carefully decant and (if made in large quantities) press off, and fill into bottles.—Pharm. Era.

VALUABLE BOOKS

NOW READY.

Twenty-Third Edition

EXPERIMENTAL SCIENCE.

By GEORGE M. HOPKINS.

Revised and Greatly Enlarged. 2 Octavo Volumes. 1,100 Pages. 900 Illustrations.

Cloth Bound, Postpaid, **$3.00.** *Half Morocco, Postpaid,* **$7.00**

Or Volumes Sold Separately:

Cloth, **$3.00** *per Volume. Half Morocco,* **$4.00** *per Volume.*

EXPERIMENTAL SCIENCE is so well known to many of our readers that it is hardly necessary now to give a description of this work. Mr. Hopkins decided some months ago that it would be necessary to prepare a new edition of this work in order that the many wonderful discoveries of modern times might be fully described in its pages. Since the last edition was published, wonderful developments in wireless telegraphy, for example, have been made. It was necessary, therefore, that a good deal of new matter should be added to the work in order to make it thoroughly up-to-date, and with this object in view some 200 pages have been added. On account of the increased size of the work it has been necessary to divide it into two volumes, handsomely bound in buckram. It may be interesting to note the following additions that have been made to these volumes:

Volume I contains in addition to a large number of simple, well illustrated experiments, a full description of a ¼ H. P. electric motor made expressly for illustration in this edition of "EXPERIMENTAL SCIENCE." It is an ENCLOSED SELF-REGULATING electric motor for a 110 volt circuit. It can be operated by a current from a 110 volt lamp-socket, yielding a full ¼ H. P., or it may be used as a dynamo, furnishing a current capable of operating three 16-candle power, 110 volt incandescent lamps. The construction of the machine is perfect enough to admit of enlarging or reducing its size if desired.

Volume II contains much on the general subject of electricity, besides new articles of great importance. Among these the subject of alternate current machinery is treated. Wireless Telegraphy and Telephony receive attention. Electrical Measuring Instruments, The Electric Clock, The Telegraphone, Experiments in High Voltage, The Nernst Lamp, and Measuring the Heat of the Stars are all thoroughly illustrated and described.

The unprecedented sale of this work shows conclusively that it is the book of the age for teachers, students, experimenters and all others who desire a general knowledge of Physics or Natural Philosophy.

SIXTEENTH REVISED AND ENLARGED EDITION OF 1901

THE SCIENTIFIC AMERICAN

Cyclopedia of Receipts, Notes and Queries

15,000 RECEIPTS. 734 PAGES

Price, **$5** *in Cloth;* **$6** *in Sheep;* **$6.50** *in Half Morocco, postpaid.*

This work has been revised and enlarged. **900 New Formulas.** The work is so arranged as to be of use not only to the specialist, but to the general reader. It should have a place in every home and workshop. A circular containing full Table of Contents will be sent on application.

Those who already have the Cyclopedia may obtain the **1901 APPENDIX.** Price, bound in cloth, $1 postpaid.

The Progress of Invention in the Nineteenth Century.

By EDWARD W. BYRN, A.M.

Large Octavo. 480 Pages. 300 Illustrations. Price **$3** *by Mail, Postpaid. Half Red Morocco, Gilt Top,* **$4.**

The most important book ever published on invention and discovery. It is as readable as a novel, being written in popular style.

The book gives a most comprehensive and coherent account of the progress which distinguishes this as the "golden age of invention," resulting in industrial and commercial development which is without precedent. A chronological calendar of the leading inventions is one of the most important features of the book, enabling the reader to refer at a glance to important inventions and discoveries of any particular year. The book is printed with large type, on fine paper, and is elaborately illustrated with 300 engravings and is attractively bound.

1902 EDITION.

ALL THE WORLD'S FIGHTING SHIPS

By FRED T. JANE, Author of the Naval War Game (Kriegspiel).

Used as a text-book in European navies. The only absolutely correct and complete work of the kind published.

394 PAGES. OVER 3,000 ILLUSTRATIONS.

OBLONG QUARTO. CLOTH. PRICE, $5.00, POST FREE

CONTAINS:—A photograph of every warship in the world; also a silhouette and a gun and armor diagram of each vessel.

CONTAINS:—The length, beam, draught, horse power, speed, coal supply, number and size of guns, thickness and disposition of armor of every warship in the world.

CONTAINS:—Tables of the size, weight, velocity, energy, penetration, etc., of every gun of every navy in the world.

CONTAINS:—A series of chapters by noted Admirals, Naval Constructors and other experts of various navies, on vital questions of the day in naval construction, tactics, and strategy.

CONTAINS:—A comparative table (by the author) of the strength to the navies of the world—the most scientific attempt yet made to classify the world's warships and navies as to actual fighting strength.

IT SHOULD BE NOTED that this work is from the pen of a naval critic and expert, whose reputation is far-reaching on both sides of the Atlantic. It will be of fascinating interest to those who follow the course of naval development, and as a book of reference should find a place in every library.

JUST PUBLISHED.

HARDENING, TEMPERING, ANNEALING AND FORGING OF STEEL.

By JOSEPH V. WOODWORTH,

Author of "Dies, Their Construction and Use."

Octavo. 280 pages. 200 Illustrations. Bound in Cloth. Price **$2.50.**

A new work from cover to cover, treating in a clear, concise manner all modern processes for the **Heating, Annealing, Forging, Welding, Hardening and Tempering** of steel, making it a book of great practical value to metal-working mechanics in general, with special directions for the successful hardening and tempering of all steel tools used in the arts, including milling cutters, taps, thread dies, reamers, both solid and shell, hollow mills, punches and dies, and all kinds of sheet metal working tools, shear blades, saws, fine cutlery, and metal cutting tools of all description, as well as for all implements of steel, both large and small. In this work the simplest and most satisfactory hardening and tempering processes are given.

The uses to which the leading brands of steel may be adapted are concisely presented and their treatment for working under different conditions explained, also the special methods for the hardening and tempering of special brands. In connection with the above, numbers of "kinks," "ways," and "practical points" are embodied, making the volume a text book on the treatment of steel as modern demands necessitate.

A chapter devoted to the different processes of **Case-hardening is also included,** and special reference made to **the adoption of Machinery Steel for Tools** of various kinds. The illustrations show the mechanic the most up-to-date devices, machines and furnaces which contribute to the attainment of satisfactory results in this highly important branch of modern tool-making. Send for descriptive circular.

MUNN & CO., Publishers, 361 Broadway, New York.

THE Scientific American Supplement

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. AUTOMOBILES.—Some Details of the Paris-Madrid Racing Automobiles.—10 illustrations 23032

II. BIOGRAPHY.—His Holiness Pope Leo XIII.—5 illustrations 23032

III. CHEMISTRY.—Industrial Application of the Diastases.—The Most Recent Discoveries 23033
Self-Igniting Devices for Coal Gas 23034

IV. COMMERCE.—The World's Coal Production 23035
Trade Suggestions from United States Consuls 23035

V. ELECTRICITY.—Electrical Notes 23034
Hertzian Wave Telegraphy.—17 illustrations 23035

VI. ELECTRO-CHEMISTRY.—Electric Sodium Manufacture in Germany 23037

VII. ENGINEERING.—Engineering Notes 23041

VIII. GEOGRAPHY.—In the Heart of Thibet 23035

IX. MECHANICS.—A Simple Circular Computing Scale.—2 illustrations 23040

X. MECHANICAL DEVICES.—Machine for Carving Wood Moldings.—2 illustrations 23034

XI. METALLURGY.—The Simplex Spraying Nozzle and Water Cooling System.—2 illustrations 23025
Vanadium Steel 23025

XII. MINERALOGY.—The Origin of the Diamond.—By E. M. SOUVIELLE 23035

XIII. MISCELLANEOUS.—Selected Formulæ 23040
Trade Notes and Recipes 23041

XIV. NAVAL WARFARE.—The Submarine Boats "Pike" and "Grampus."—1 illustration 23032

XV. OPTICS.—Aberration of the Sphericity of the Eye 23035

XVI. PHYSICS.—Direct Production of X-Rays in the Air 23029
Investigations in Phonograph Phenomena 23035

XVII. RAILWAYS.—American Railway Equipment 23034

XVIII. STEAM ENGINEERING.—Marine Engines.—By A. E. POTTER 23034

JUST READY.

DIES, THEIR CONSTRUCTION AND USE,

For the Modern Working of Sheet Metals.

By JOSEPH V. WOODWORTH.

Octavo. Cloth. Very Fully Illustrated. Price $3.00 Postpaid.

This book is a complete treatise on the subject and the most comprehensive and exhaustive one in existence. A book written by a practical man for practical men, and one that no diemaker, machinist, toolmaker or metal-working mechanic can afford to be without.

Dies, press fixtures and devices from the simplest to the most intricate in modern use, are shown, and their construction and use described in a clear, practical manner, so that all grades of metal-working mechanics will be able to understand thoroughly how to design, construct and use them, for the production of the endless variety of sheet-metal articles now in daily use.

Many of the dies described in this book were designed and constructed by the author personally, others under his personal supervision, while others were constructed and used in the press rooms of some of the largest sheet-metal goods establishments and machine shops in the United States. A number of the dies, press fixtures and devices, which form a part of this book, have been selected from over 150 published articles, which were contributed by the author to the columns of the "American Machinist," "Machinery" and the "Age of Steel," under his own name.

No obsolete die, press fixture or device has found a place in this book; every engraving between its covers represents the highest that has been attained in the development of each type described. The descriptions of their construction and use will enable the practical man to adapt them for facilitating, duplicating and expediting the production of sheet-metal articles at the minimum of cost and labor.

Every manager, superintendent, designer, draftsman, foreman, diemaker, machinist, toolmaker or apprentice should have this book.

MUNN & CO., Publishers, 361 Broadway, New York.

THE NEW SUPPLEMENT CATALOGUE

Just Published

A LARGE edition of the SUPPLEMENT Catalogue in which is contained a complete list of valuable papers down to the year 1902, is now ready for distribution, free of charge. The new Catalogue is exactly like the old in form, and is brought strictly up to date. All the papers listed are in print and can be sent at once at the cost of ten cents each, to any part of the world. The Catalogue contains 60 three-column pages and comprises 15,000 papers. The Catalogue has been very carefully prepared and contains papers in which information is given that cannot be procured in many textbooks published. Write for the new Catalogue to-day to

MUNN & CO., Publishers, 361 Broadway, New York

PATENTS!

MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine inventions, and to act as Solicitors of Patents for Inventors.

In this line of business they have had over *fifty years' experience,* and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. MUNN & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge,* a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.